

Aerobic and Anaerobic Degradation in Aquatic Systems

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Report: Meyer, B.N. (2012) Aerobic Aquatic and Anaerobic Aquatic Degradation of Pyrethroid Insecticides in Three California Sediments. Unpublished study performed by Bayer CropScience, and sponsored by the Pyrethroid Working Group (PWG, Consortium No. 64977) (c/o Richard H. Collier, Landis International, Inc.). Report number RAAAY023. Study completion date February 10, 2012.

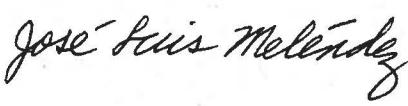
Guideline: Reviewed by OCSPP 835.4300 (aerobic) and OCSPP 835.4400 (anaerobic); the study was conducted as part of a data requirement from California Department of Pesticide Regulation (CDPR), and the study design had certain differences from guideline requirements as specified below.

Statements: The study was conducted in compliance with Good Laboratory Practice Standards (GLPS) set forth in Title 40, Part 160 of the Code of Federal Regulations (p. 3). Signed and dated Data Confidentiality, GLP Compliance, Quality Assurance, and Authenticity Certification statements were provided (pp. 2-5).

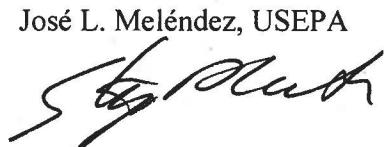
Classification: This study is considered supplemental. Water and sediment were not tested separately. Instead, water and sediment were extracted together. The runs were conducted for a period of up to 108 days while for many of the pyrethroids, the calculated DT₅₀s and/or DT₉₀s were above 100-108 days. Non-radiolabeled material was used in this study; therefore, the presence of possible transformation products and unextracted residues was not verified. For two of the aerobic sediment systems, the sediment may not have been aerobic. For a large number of chemicals, the initial concentrations were relatively low.

PC Codes:

Bifenthrin	128825
Beta-cyfluthrin	118831
Cyfluthrin	128831
Gamma-cyhalothrin	128807
Lambda-cyhalothrin	128897
Zeta-cypermethrin	129064
Cypermethrin	109702
Deltamethrin	097805
Esfenvalerate	109303
Fenpropathrin	127901
Permethrin	109701

Signature: 

Reviewer: José L. Meléndez, USEPA Date: August 27, 2013

Signature: 

Reviewer: Stephen P. Wente, USEPA Date: August 27, 2013

Executive Summary

The aerobic and anaerobic transformation of non-radiolabeled bifenthrin, *beta*-cyfluthrin, cyfluthrin, *gamma*-cyhalothrin, *lambda*-cyhalothrin, *zeta*-cypermethrin, cypermethrin, deltamethrin, fenpropathrin, esfenvalerate, and permethrin, was studied in three H₂O:sediment systems for up to 108 days in darkness at 25±1°C.

Table 1. Sediment Systems

Water:sediment ID	Water column pH ¹		Sediment pH ²	Sediment Organic Carbon Content (%) ²
	Aerobic	Anaerobic		
Sediment 1: Sand	8.1	7	6.8	0.6
Sediment 2: Clay	7.8	6.6	6.0	7.4
Sediment 3: Sandy Clay Loam	8.1	6.7	6.9	2.7

1 As measured at study initiation in the test system. 2 Measured prior to study initiation.

During the course of the anaerobic study, anaerobic conditions were maintained based on negligible amounts of oxygen content and pE + pH <12. For the aerobic sediments, the oxygen content was orders of magnitude higher. Microbial biomass determinations indicated the water sediment systems were viable at study initiation and termination.

Observed DT₅₀ values, calculated half-lives based on the harmonized NAFTA kinetics guidance (USEPA, 2011), are listed in **Tables 2a to 2c**. Based on recoveries of concurrent samples, it appeared like the test procedure maximized recoveries of residues. No attempts to determine amounts of unextracted residues or transformation products were made since the test materials were non-radiolabeled. Volatiles were not measured. Additionally, no attempts to measure separately the amount of material in the water and sediment were made. Synthetic pyrethroids are known to bind to sediments and they are expected to partition relatively rapidly with the sediment phase.

Table 2a. Result Synopsis (summary table, all sediments)

Sediment Type	Aerobic						Anaerobic					
Sediment ID	Sed 1		Sed 2		Sed 3		Sed 1		Sed 2		Sed 3	
DT ₅₀ s and t _R s (days)	DT ₅₀	t _R										
Bifenthrin (1)	104	104	455	455	114	114	992	992	330	330	307	307
Bifenthrin (2)	98.7	98.7	275	275	87.3	87.3	9391	9391	269	269	267	267
<i>Beta</i> -cyfluthrin	2.05	7.68	7.95	34.1	2.47	9.76	13.9	51.8	22	22	17.8	29.2
Cyfluthrin	3.96	10.4	10.4	47.6	2.92	7.71	24	48.3	21.6	42.4	17.1	29.2
<i>Gamma</i> -cyhalothrin	11.8	38.6	55.9	55.9	17.1	29.9	98.3	123	101	101	72.8	72.8
<i>Lambda</i> -cyhalothrin	15.6	82.2	60.4	60.4	13.3	25.9	87	146	92.8	92.8	62.4	62.4
<i>Zeta</i> -cypermethrin	3.86	11.3	12.7	54.9	4.11	13.8	34.2	70.4	27.3	50.1	32.9	39.6
Cypermethrin	3.28	7.01	9.04	37.9	2.48	5.88	28.1	28.1	20.6	37.1	17.2	27.8
Deltamethrin	9.74	9.74	37.1	91.2	9.17	37.3	106	162	60	327	59.8	59.8
Esfenvalerate	13.3	50.3	39.1	81.2	22.4	31.7	94.7	94.7	72.3	72.3	66.6	66.6

Table 2a. Result Synopsis (summary table, all sediments)

Sediment Type	Aerobic						Anaerobic					
Sediment ID	Sed 1		Sed 2		Sed 3		Sed 1		Sed 2		Sed 3	
DT _{50s} and t _{Rs} (days)	DT ₅₀	t _R										
Fenpropathrin	7.27	23.5	63.3	63.3	6.88	15.6	92.2	298	115	115	94.9	94.9
Permethrin	2.28	5.93	39.7	77.4	2.12	6.37	96.9	204	56.1	229	66.2	66.2

DT_{50s} are model-calculated values. For observed values, refer to **Tables 2b and 2c**. t_R is the representative half-life which is selected by the PestDFV1.0 module of R, according to USEPA 2011 and generally used for modeling purposes. Sediment systems as described in **Table 1**.

Table 2b. Results Synopsis: Aerobic Aquatic Metabolism of Eleven Synthetic Pyrethroids in Three Sediment Systems

Test Substance	Total System ¹	Observed DT ₅₀ (days)	Calculated DT ₅₀ (days)	Representative Half-life (days) [Method]	Model Parameters and Statistics
Bifenthrin (Measurement #1)	<u>Sediment System 1:</u> H ₂ O:sand, 0.6% OC, pH 6.8, 25°C	59-100	104	104 [SFO]	C ₀ = 84.5, k = 0.00666
	<u>Sediment System 2:</u> H ₂ O:clay, 7.4% OC, pH 6.0, 25°C	>103	455	455 [SFO]	C ₀ = 91.9, k = 0.00152
	<u>Sediment System 3:</u> H ₂ O:sandy clay loam, 2.7% OC, pH 6.9, 25°C	58-100	114	114 [SFO]	C ₀ = 88.2, k = 0.00605
Bifenthrin (Measurement #2)	Sediment System 1	59-100	98.7	98.7 [SFO]	C ₀ = 98.3, k = 0.00702
	Sediment System 2	>103	275	275 [SFO]	C ₀ = 92.1, k = 0.00252
	Sediment System 3	58-100	87.3	87.3 [SFO]	C ₀ = 93.3, k = 0.00794
Beta-cyfluthrin	Sediment System 1	0-3	2.05	7.68 [DFOP]	C ₀ = 96, f = 0.399, k ₀ = 3.88, k ₁ = 0.0902
	Sediment System 2	ca. 7	7.95	34.1 [IORE]	C ₀ = 95.8, k = 0.000276, N = 2.37
	Sediment System 3	0-3	2.47	9.76 [IORE]	C ₀ = 94, k = 0.00118, N = 2.31
Cyfluthrin	Sediment System 1	3-7	3.96	10.4 [IORE]	C ₀ = 94.6, k = 0.003, N = 1.97
	Sediment System 2	7-14	10.4	47.6 [DFOP]	C ₀ = 96.3, f = 0.494, k ₀ = 0.196, k ₁ = 0.0146
	Sediment System 3	0-3	2.92	7.71 [IORE]	C ₀ = 94, k = 0.004, N = 1.98
Gamma-cyhalothrin	Sediment System 1	7-14	11.8	38.6 [IORE]	C ₀ = 97.5, k = 0.000444, N = 2.16
	Sediment System 2	28-60	55.9	55.9 [SFO]	C ₀ = 89.8, k = 0.0124
	Sediment System 3	14-28	17.1	29.9 [DFOP]	C ₀ = 101, f = 0.257, k ₀ = 4.96, k ₁ = 0.0232
Lambda-cyhalothrin	Sediment System 1	7-14	15.6	82.2 [IORE]	C ₀ = 104, k = 6.42x10 ⁻⁵ , N = 2.53
	Sediment System 2	ca. 60	60.4	60.4 [SFO]	C ₀ = 88.8, k = 0.0115
	Sediment System 3	7-14	13.3	25.9 [IORE]	C ₀ = 96.6, k = 0.00266, N = 1.71

Table 2b. Results Synopsis: Aerobic Aquatic Metabolism of Eleven Synthetic Pyrethroids in Three Sediment Systems

Test Substance	Total System ¹	Observed DT ₅₀ (days)	Calculated DT ₅₀ (days)	Representative Half-life (days) [Method]	Model Parameters and Statistics
Zeta-cypermethrin	Sediment System 1	3-7	3.86	11.3 [IORE]	C ₀ = 91, k = 0.00219, N = 2.06
	Sediment System 2	7-14	12.7	54.9 [DFOP]	C ₀ = 97.6, f = 0.502, k ₀ = 0.148, k ₁ = 0.0126
	Sediment System 3	3-7	4.11	13.8 [IORE]	C ₀ = 92.6, k = 0.00126, N = 2.18
Cypermethrin	Sediment System 1	3-7	3.28	7.01 [IORE]	C ₀ = 95.6, k = 0.00763, N = 1.79
	Sediment System 2	7-14	9.04	37.9 [IORE]	C ₀ = 99, k = 0.000249, N = 2.36
	Sediment System 3	0-3	2.48	5.88 [IORE]	C ₀ = 93.1, k = 0.00699, N = 1.88
Delta-methrin	Sediment System 1	7-14	9.74	9.74 [SFO]	C ₀ = 103, k = 0.0712
	Sediment System 2	28-60	37.1	91.2 [IORE]	C ₀ = 99, k = 0.000387, N = 1.92
	Sediment System 3	7-14	9.17	37.3 [IORE]	C ₀ = 102, k = 0.000261, N = 2.33
Esfenvalerate	Sediment System 1	7-14	13.3	50.3 [IORE]	C ₀ = 94.3, k = 0.000252, N = 2.28
	Sediment System 2	28-60	39.1	81.2 [DFOP]	C ₀ = 101, f = 0.311, k ₀ = 0.0993, k ₁ = 0.00853
	Sediment System 3	14-28	22.4	31.7 [DFOP]	C ₀ = 99.1, f = 0.185, k ₀ = 0.491, k ₁ = 0.0218
Fenpropathrin	Sediment System 1	ca. 7	7.27	23.5 [IORE]	C ₀ = 99.7, k = 0.000741, N = 2.15
	Sediment System 2	60-103	63.3	63.3 [SFO]	C ₀ = 89.2, k = 0.109
	Sediment System 3	3-7	6.88	15.6 [IORE]	C ₀ = 92.8, k = 0.00296, N = 1.85
Permethrin	Sediment System 1	0-3	2.28	5.93 [IORE]	C ₀ = 95.2, k = 0.00535, N = 1.96
	Sediment System 2	28-60	39.7	77.4 [DFOP]	C ₀ = 95.1, f = 0.287, k ₀ = 0.243, k ₁ = 0.00895
	Sediment System 3	0-3	2.12	6.37 [IORE]	C ₀ = 100, k = 0.00328, N = 2.08

1 The pH value reported was measured in a 1:1 soil:water mixture.

Table 2c. Results Synopsis: Anaerobic Aquatic Metabolism of Eleven Synthetic Pyrethroids in Three Sediment Systems

Test Substance	Total System ¹	Observed DT ₅₀ (days)	Calculated DT ₅₀ (days)	Representative Half-life (days) [Method]	Model Parameters and Statistics
Bifenthrin (Measurement #1)	<u>Sediment System 1:</u> H ₂ O:sand, 0.6% OC, pH 6.8, 25°C	>101	992	992 [SFO]	C ₀ = 94.5, k = 0.000699
	<u>Sediment System 2:</u> H ₂ O:clay, 7.4% OC, pH 6.0, 25°C	>104	330	330 [SFO]	C ₀ = 79.8, k = 0.0021

Table 2c. Results Synopsis: Anae robic Aquatic Metabolism of Eleven Synthetic Pyrethroids in Three Sediment Systems

Test Substance	Total System ¹	Observed DT ₅₀ (days)	Calculated DT ₅₀ (days)	Representative Half-life (days) [Method]	Model Parameters and Statistics
	<u>Sediment System 3:</u> H ₂ O:sandy clay loam, 2.7% OC, pH 6.9, 25°C	>100	307	307 [SFO]	C ₀ = 79.2, k = 0.00225
Bifenthrin (Measurement #2)	Sediment System 1	>101	9391	9391 [SFO]	C ₀ = 92.4, k = 7.38x10 ⁻⁵
	Sediment System 2	>104	269	269 [SFO]	C ₀ = 80, k = 0.00258
	Sediment System 3	>100	267	267 [SFO]	C ₀ = 79.5, k = 0.00259
<i>Beta</i> -cyfluthrin	Sediment System 1	ca. 11	13.9	51.8 [DFOP]	C ₀ = 95.5, f = 0.398, k ₀ = 1.03, k ₁ = 0.0134
	Sediment System 2	14-28	22	22 [SFO]	C ₀ = 91.3, k = 0.0315
	Sediment System 3	ca. 14	17.8	29.2 [IORE]	C ₀ = 93.8, k = 0.00406, N = 1.54
Cyfluthrin	Sediment System 1	11-19	24	48.3 [IORE]	C ₀ = 94.8, k = 0.00132, N = 1.74
	Sediment System 2	14-28	21.6	42.4 [IORE]	C ₀ = 99, k = 0.00156, N = 1.72
	Sediment System 3	ca. 14	17.1	29.2 [IORE]	C ₀ = 96.6, k = 0.00348, N = 1.58
Gamma-cyhalothrin	Sediment System 1	ca. 101	98.3	123 [DFOP]	C ₀ = 101, f = 0.128, k ₀ = 0.164, k ₁ = 0.00565
	Sediment System 2	61-104	101	101 [SFO]	C ₀ = 89.8, k = 0.00683
	Sediment System 3	59-100	72.8 ²	72.8 [SFO] ²	C ₀ = 98, k = 0.00952
<i>Lambda</i> -cyhalothrin	Sediment System 1	60-101	87	146 [DFOP]	C ₀ = 99.8, f = 0.245, k ₀ = 0.214, k ₁ = 0.00474
	Sediment System 2	61-104	92.8	92.8 [SFO]	C ₀ = 92.6, k = 0.00747
	Sediment System 3	ca. 59	62.4	62.4 [SFO]	C ₀ = 92.4, k = 0.0111
Zeta-cypermethrin	Sediment System 1	19-28	34.2	70.4 [DFOP]	C ₀ = 93.4, f = 0.3, k ₀ = 0.344, k ₁ = 0.00985
	Sediment System 2	14-28	27.3	50.1 [IORE]	C ₀ = 96.6, k = 0.00164, N = 1.65
	Sediment System 3	28-59	32.9	39.6 [DFOP]	C ₀ = 95.5, f = 0.113, k ₀ = 0.147, k ₁ = 0.0175
Cypermethrin	Sediment System 1	11-19	28.1	28.1 SFO]	C ₀ = 92, k = 0.0246
	Sediment System 2	14-28	20.6	37.1 [IORE]	C ₀ = 98.1, k = 0.00231, N = 1.63
	Sediment System 3	14-28	17.2	27.8 [IORE]	C ₀ = 99.2, k = 0.00433, N = 1.53
Deltamethrin	Sediment System 1	ca. 108	106	162 [DFOP]	C ₀ = 98.7, f = 0.213, k ₀ = 0.062, k ₁ = 0.00429
	Sediment System 2	ca. 61	60	327 [IORE]	C ₀ = 104, k = 1.49x10 ⁻⁵ , N = 2.56
	Sediment System 3	ca. 59	59.8	59.8 [SFO]	C ₀ = 99.5, k = 0.0116
Esfenvalerate	Sediment System 1	ca. 101	94.7 ³	94.7 [SFO] ³	C ₀ = 92.8, k = 0.00732
	Sediment System 2	ca. 61	72.3	72.3 [SFO]	C ₀ = 94.9, k = 0.00959
	Sediment System 3	59-100	66.6	66.6 [SFO]	C ₀ = 97.3, k = 0.0104

Table 2c. Results Synopsis: Anaerobic Aquatic Metabolism of Eleven Synthetic Pyrethroids in Three Sediment Systems

Test Substance	Total System ¹	Observed DT ₅₀ (days)	Calculated DT ₅₀ (days)	Representative Half-life (days) [Method] ²	Model Parameters and Statistics
Fenpropathrin	Sediment System 1	ca. 11	92.2	298 [DFOP]	C ₀ = 101, f = 0.381, k ₀ = 0.207, k ₁ = 0.00233
	Sediment System 2	61-104	115	115 [SFO]	C ₀ = 84.3, k = 0.00601
	Sediment System 3	59-100	94.9	94.9 [SFO]	C ₀ = 85.5, k = 0.0073
Permethrin	Sediment System 1	60-101	96.9	204 [DFOP]	C ₀ = 94.2, f = 0.305, k ₀ = 0.0775, k ₁ = 0.0034
	Sediment System 2	ca. 61	56.1	229 [IORE]	C ₀ = 98.9, k = 4.36x10 ⁻⁵ , N = 2.34
	Sediment System 3	59-100	66.2	66.2 [SFO]	C ₀ = 95.7, k = 0.0105

1 The pH value reported was measured in a 1:1 soil: water mixture.

2 For gamma-cyhalothrin in sediment 3, SFO results were used as representative. The tool PestDFV1.0 yields a representative half-life of 40.7 days. Inspection of the data shows that the observed DT₅₀ is 59-100 days and the calculated DT₅₀ is 76.6 days using the tool-selected IORE model. Since the representative half-life does not appear to be conservative and the N value is negative, a half-life from the SFO model was selected.

3 For esfenvalerate in sediment 1, SFO results were used as representative. Given that DFOP did not run in PestDFV1.0, the Excel Solver was used to fit the data. SFO was found to provide the best fit.

I. Materials and Methods

A. Materials:

- 1. Test Material:** For structures of the test substances, see **Attachment 1**. The test materials were not radiolabeled.
Solubility in water: Not reported

- 2. Reference Compounds:**

Table 3. Reference Compounds

Applicant's Code Name	PC Code	Chemical Name	Purity (%)	Lot No.
Bifenthrin	128825	(2-Methyl[1 , 1 '-biphenyl]-3-yl)methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropane carboxylate	98.8	G0101:96
<i>Beta</i> -cyfluthrin	118831	Cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate	96.8	K-699
Cyfluthrin	128831	Cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate	50.2 ¹	K-700
<i>Gamma</i> -cyhalothrin	128807	Cyclopropanecarboxylic acid, 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethyl-,cyano(3-phenoxyphenyl)methyl ester, [1R-[1a(S*),3a(Z)]]	99.5	829-KEN-26-1
<i>Lambda</i> -cyhalothrin	128897	[1a(S*),3a(Z)]-(±)-cyano(3-phenoxyphenyl)methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate	98.7	485403
<i>Zeta</i> -cypermethrin	129064	Cyclopropanecarboxylic acid, cis-(+)-3-(2,2-dichloroethenyl)-2,2-dimethyl-, (S)-cyano(3-phenoxyphenyl)methyl ester AND cyclopropanecarboxylic acid, trans-(+)-3-(2,2-dichloroethenyl)-2,2-dimethyl-, (S)-cyano(3-phenoxyphenyl)methyl ester	36.5 ²	F2700
Cypermethrin	109702	(+/-)-a-cyano(3-phenoxyphenyl)methyl(+/-) cis. trans- 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropane carboxylate	93.0	PL07-0633
Delta methrin	097805	(S)-Cyano(3-phenoxyphenyl)methyl(1R,3R)-3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylate	99.4	K-1375
Esfenvalerate	109303	((S)-Cyano(3-phenoxyphenyl)methyl(S)-4-chloro-a/p/7a-(1-methylethyl)benzeneacetate)	98.7	0035739
Fenpropathrin	129701	Alpha-cyano-3-phenoxybenzyl-2,2,3,3-tetramethylcyclopropane carboxylate	99.7	AS 459h
Permethrin	109701	(3-Phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate	96.2	VTC1 06633

Data were obtained from Figure 1, pp. 48-52 of the study report.

1 Solution in cyclohexanone.

2 No further description was provided.

3. Water-sediment: Sediment samples were obtained from three locations in California. Water was not from those locations; rather, it was water that is used routinely in ecotoxicity tests. Water and sediment collection and characterization are summarized in **Table 4** and **Tables 5a to 5c**, respectively.

Table 4. Water:Sediment Collection and Storage

Description		Water:sediment system 1	Water:sediment system 2	Water:sediment system 3
Geographic location		San Diego County, East of San Diego, CA	White Slough (King Island) Contra Costa County, CA	Franks Tract State Recreation Area, Contra Costa County, CA
Pesticide use history at the collection site		Not reported.		
Collection procedures	Water:	Water samples were not collected with the sediments. Water utilized was routinely conditioned for ecotoxicity tests in Bayer facilities in Stillwell, KS.		
	Sediment:	Not reported.		
Storage temperature		Refrigerated under dark.		
Storage length (Aerobic)		3 days	22 days	21 days
Storage length (Anaerobic)		54 days	43 days	54 days
Preparation	Water:	Water consists of a blend of filtered and UV-sterilized spring water and municipal water which was de-chlorinated, filtered, demineralised using softeners, treated by reverse osmosis twice, and UV-sterilized.		
	Sediment:	Sieved (2 mm) and thoroughly mixed.		

Data obtained from pages 16, 23 (Table 1), and 87 (Appendix 2) of the study report.

Reported time was reviewer calculated from the dates of sediment collection to the start of acclimation (p. 87).

Table 5a. Parameters for Characterization of Water:Sediment System 1 (Sand)

Parameter (unit)	Field Sampling/Post Handling	Stage of Test Procedure		
		Prior to Test	During Test	End of Test
Water				
Temperature (°C)	Not applicable. ¹			
pH (aerobic study)	Not applicable. ¹	8.1	5.9-8.3	5.9
pH (anaerobic study)	Not applicable. ¹	7.0	6.9-7.1	7.0
TOC (mg/L) (aerobic study)		Not reported.	Not reported.	Not reported.
TOC (mg/L) (anaerobic study)		Not reported.	Not reported.	Not reported.
O ₂ concentration (mg/L) (aerobic study)	Not applicable. ¹	5.5	5.3-6.2	6.4
O ₂ concentration (mg/L) (anaerobic study)	Not applicable. ¹	0.1	0.0-0.2	0.4
Standard redox potential (mV) (aerobic study)		366.7	245.5-479.8	492.0
Standard redox potential (mV) (anaerobic study)		178.0	10.3-138.2	1.6
Sediment				
Sampling Depth (cm)	Not reported.			
pH (aerobic study)	6.8 ³	Not reported.	Not reported.	Not reported.
pH (anaerobic study)		Not reported.	Not reported.	Not reported.

Parameter (unit)	Field Sampling/Post Handling	Stage of Test Procedure		
		Prior to Test	During Test	End of Test
Particle Size Distribution	90.3% sand (2000-50 µm) 1.8% silt (50-2 µm) 7.9% clay (<2 µm)			
OC (%) (aerobic study)	0.6	Not reported.		Not reported.
OC (%) (anaerobic study)		Not reported.		Not reported.
Soil microbial count (CFU/g dry wt. soil, bacteria) (aerobic study) ²	Not reported.	793,000		1,490,000
Soil microbial count (CFU/g dry wt. soil, anaerobic agar) (anaerobic study) ²		252,000		50,300
Standard redox potential (mV) (aerobic study)		420.7	96.9-488.1	505.7
Standard redox potential (mV) (anaerobic study)		170.2	0.0-140.6	9.6

Data were obtained from pp. 27-29 (Tables 5-7) of study report.

1 Water samples were not collected from the same site than the sediments. The microbial biomass (mg CO₂/hr/kg dry wt.) was not reported. See text.

2 Measured in solvent control samples.

3 Measured in 1:1 soil:water.

Table 5b. Parameters for Characterization of Water:Sediment System 2 (Clay)

Parameter (unit)	Field Sampling/Post Handling	Stage of Test Procedure		
		Prior to Test	During Test	End of Test
Water				
Temperature (°C)	Not applicable. ¹			
pH (aerobic study)	Not applicable. ¹	7.8	5.6-8.4	7.7
pH (anaerobic study)		6.6	6.3-6.7	6.7
TOC (mg/L) (aerobic study)		Not reported.	Not reported.	Not reported.
TOC (mg/L) (anaerobic study)		Not reported.	Not reported.	Not reported.
O ₂ concentration (mg/L) (aerobic study)	Not applicable. ¹	5.5	4.5-6.0	5.9
O ₂ concentration (mg/L) (anaerobic study)		0.2	0.1-0.2	0.1
Standard redox potential (mV) (aerobic study)		243.0	199.5-456.6	283.7
Standard redox potential (mV) (anaerobic study)		104.2	95.4-109.8	100.9
Sampling Depth (cm)				
Sampling Depth (cm)	Not reported.			
pH (aerobic study)	6.0 ³	Not reported.	Not reported.	Not reported.
pH (anaerobic study)		Not reported.	Not reported.	Not reported.
Particle Size Distribution	20.4% sand (2000-50 µm) 30.1% silt (50-2 µm) 49.5% clay (<2 µm)			
OC (%) (aerobic study)	7.4	Not reported.		Not reported.

Parameter (unit)	Field Sampling/Post Handling	Stage of Test Procedure		
		Prior to Test	During Test	End of Test
		Not reported.		Not reported.
OC(%) (anaerobic study)	Not reported.	434,000		126,000
Soil microbial count (CFU/g dry wt. soil, bacteria) (aerobic study) ²		59,000		41,800
Soil microbial count (CFU/g dry wt. soil, anaerobic agar) (anaerobic study) ²		72.7	65.4-100.9	149.8
Standard redox potential (mV) (aerobic study)		100.5	101.5-112.6	98.6
Standard redox potential (mV) (anaerobic study)				

Data were obtained from pp. 27-29 (Tables 5-7) of study report.

1 Water samples were not collected from the same site than the sediments. The microbial biomass (mg CO₂/hr/kg dry wt.) was not reported. See text.

2 Measured in solvent control samples.

3 Measured in 1:1 soil:water.

Table 5c. Parameters for Characterization of Water:Sediment System 3 (Sandy Clay Loam)

Parameter (unit)	Field Sampling/Post Handling	Stage of Test Procedure		
		Prior to Test	During Test	End of Test
Water				
Temperature (°C)	Not applicable. ¹			
pH (aerobic study)	Not applicable. ¹	8.1	5.7-8.5	6.8
pH (anaerobic study)		6.7	6.7-6.8	6.9
TOC (mg/L) (aerobic study)		Not reported.	Not reported.	Not reported.
TOC (mg/L) (anaerobic study)		Not reported.	Not reported.	Not reported.
O ₂ concentration (mg/L) (aerobic study)	Not applicable. ¹	5.4	4.9-6.0	5.8
O ₂ concentration (mg/L) (anaerobic study)		0.1	0.1-0.3	0.1
Standard redox potential (mV) (aerobic study)		270.4	378.0-461.6	390.7
Standard redox potential (mV) (anaerobic study)		105.7	79.3-165.2	193.0
Soil				
Sampling Depth (cm)	Not reported.			
pH (aerobic study)	6.9 ³	Not reported.	Not reported.	Not reported.
pH (anaerobic study)		Not reported.	Not reported.	Not reported.
Particle Size Distribution	49.5% sand (2000-50 µm) 25.9% silt (50-2 µm) 24.6% clay (<2 µm)			
OC(%) (aerobic study)	2.7	Not reported.		Not reported.
OC(%) (anaerobic study)		Not reported.		Not reported.

Parameter (unit)	Field Sampling/Post Handling	Stage of Test Procedure		
		Prior to Test	During Test	End of Test
Soil microbial count (CFU/g dry wt. soil, bacteria) (aerobic study) ²	Not reported.	125,000		60,700
Soil microbial count (CFU/g dry wt. soil, anaerobic agar) (anaerobic study) ²		24,900		14,000
Standard redox potential (mV) (aerobic study)		105.7	58.8-165.2	193.0
Standard redox potential (mV) (anaerobic study)		56.9	44.3-55.0	50.2

Data were obtained from pp. 27-29 (Tables 5-7) of study report.

1 Water samples were not collected from the same site than the sediments. The microbial biomass (mg CO₂/hr/kg dry wt.) was not reported. See text.

2 Measured in solvent control samples.

3 Measured in 1:1 soil:water.

B. Study Design:

- Experimental Conditions:** In lieu of individual vessels per chemical tested, two mixtures of six chemicals were prepared and each one added to sediment samples. Therefore, in each case six pyrethroids were tested simultaneously, in each of the sediments, and under aerobic and anaerobic conditions. Mixtures were as follows:

Test Mixture 1	Test Mixture 2
Bifenthrin	Bifenthrin
<i>Beta</i> -cyfluthrin	Cyfluthrin
<i>Gamma</i> -cyhalothrin	<i>Lambda</i> -cyhalothrin
<i>Zeta</i> -cypermethrin	Cypermethrin
Deltamethrin	Fenpropathrin
Esfenvalerate	Permethrin

Table 6 summarizes the experimental conditions.

Table 6. Experimental Design

Experimental Design	Details		
Duration of the test	100-108 days		
Water:			
Type and size of filter used	Conditioned tap water was used. Various filters were used; however, they are not further described.		
Amount of sediment and water per treatment:	Sediment 1	Sediment 2	Sediment 3
Identification			
	Aerobic		
Water (mL, including sediment water) (aerobic)	200	270	260
Sediment (g dry wt.) (aerobic)	50	50	50
Water/sediment ratio (mL: g dry weight) (aerobic)	4:1	5.4:1	5.2:1
	Anaerobic		
Water (mL, including sediment water) (anaerobic)	150	150	150
Sediment (g dry wt.) (anaerobic)	50	25	50

Experimental Design		Details		
Water/sediment ratio (mL: g dry weight) (anaerobic)		3:1	6:1	3:1
Application rates:				
No nominal	0.05 mg a.i./kg sediment for each test substance (50 ppb)			
Actual	0.05 mg a.i./kg sediment			
Number of replicates:				
Control, if used	Two			
Treated	Two per test interval.			
Test apparatus:				
Type/ material/volume (aerobic)	Foil-covered 500-mL cylindrical flask with air inlet.			
Type/ material/volume (anaerobic)	250-mL Pyrex Erlenmeyer flask with side-arm and mineral oil bubblers.			
Type/ material/volume (controls)	Controls prepared in 250-mL screw-cap glass jars.			
Details of traps for CO ₂ and organic volatile, if any	Traps were not utilized.			
If no traps were used, is the system closed?	No.			
Identity and final concentration (based on water volume) of co-solvent	Acetonitrile, 250 µL in all experiments, except for 125 µL for sediment 2 anaerobic, which contained 25 g dw. 250 µL/200-270 mL (aerobic), and 250 µL/150 mL (anaerobic), except for sediment 2 anaerobic 150 µL/150 mL.			
Test material application method:				
Volume of the test solution used/treatment	250 µL in all experiments, except for 125 µL for sediment 2 anaerobic, which contained 25 g dw.			
Application method (<i>i.e.</i> , mixed/not mixed)	Uniformly applied with an electronic pipette (Eppendorf Repeater® Xtream).			
Any indication of the test material adsorbing to the walls of the test apparatus?	Not reported. Synthetic pyrethroids are known to adsorb to walls of test apparatus. In this case, glassware was silanized.			
Microbial biomass/population of control units:				
Water	Biomass not reported, see microbial count in Tables 5a to 5c of DER.			
Sediment	Biomass not reported, see microbial count in Tables 5a to 5c of DER.			
Microbial biomass/population of treated:				
Water	Biomass not reported, see microbial count in Tables 5a to 5c of DER.			
Sediment	Biomass not reported, see microbial count in Tables 5a to 5c of DER.			
Experimental conditions:				
Temperature	25±1°C			
Continuous darkness (yes/no)	Yes			
Other details, (if any)				

Data were obtained from pages 16, 25 (Table 3) of study report.

2. Sampling during Study Period: At each sampling period, two samples per sediment per condition (aerobic and anaerobic) were pulled. **Table 7** summarizes sampling during the study period.

Table 7. Sampling During Study Period

Parameter	Details		
Sampling intervals (days)	Sediment 1	Sediment 2	Sediment 3
Aerobic	0, 3, 7, 14, 28, 59, 100	0, 3, 7, 14, 28, 60, 103	0, 3, 7, 14, 28, 58, 100
Anaerobic	0, 3, 7, 11, 19, 28, 60, 101, 108 ¹	0, 3, 7, 14, 28, 61, 104	0, 3, 7, 14, 28, 59, 100
Sampling method	At each sampling period, two samples were pulled from each condition (aerobic and anaerobic). Acetonitrile (250 mL) was added to test system.		
Method of collection of CO ₂ and organic volatile compounds	Volatiles were not collected.		
Sampling Intervals/Times			
Redox potential in water layer	Measured at each sampling interval.		
Dissolved oxygen in water layer			
pH in water layer			
Redox potential in sediment			
pH in sediment	Measured only prior to initiation of the study.		
Other details, if any			

Data were obtained from page 26 (Table 4) of study report.

¹ Sampling at 108 days occurred for analysis of deltamethrin only.

3. Analytical Procedures: In lieu of separating the water and sediment phases, in this study both phases were tested jointly. Samples (water plus sediment) were extracted with acetonitrile and then a mixture of acetonitrile/water as described below (more detail in Appendix 3, starting in p. 88 of the study report).

Separation of the Water and Sediment: The water layer was not separated from the sediment layer.

Extraction/Clean Up/Concentration Methods: Water and sediment together were extracted with 250 mL acetonitrile, incubation flask was rinsed, and all contents shaken in a mechanical shaker for 30 minutes in a 1-L plastic bottle. After vacuum filtering, the remaining sediment was extracted with acetonitrile: water (50 mL, 4:1, v/v). The plastic bottle was rinsed and filtrates were combined and adjusted to a total volume of 700 mL with water total extract.

For each of the analytes, except deltamethrin, a 1 g ENVI-Carb cartridge was conditioned with dichloromethane, followed by acetonitrile, followed by acetonitrile: water (4:1 v/v). A 70 mL aliquot of the total extract was passed through the conditioned cartridge. After rinses were also passed through the cartridge, the cartridge was rinsed with one reservoir volume of acetonitrile: water (3:2, v/v) and one reservoir volume of methanol. The analytes were eluted from the rinsed cartridge with 2-cartridge volumes of dichloromethane. The resulting solution was evaporated to dryness at 40°C with a turbovap and reconstituted in 5 mL volume of methylene chloride: cyclohexane (2:3, v/v) (pp. 105-106 of the study report). This solution was then applied to a 1 g ENVI-Carb cartridge, which was conditioned with dichloromethane: cyclohexane (2:3 v/v), and rinsed with methylene chloride: cyclohexane (2:3, v/v). A 250 µL aliquot of an internal standard of 1.0 ppm cyfluthrin-d₆ was added to the collected rinse, which is evaporated to dryness and re-dissolved in 1.00 mL cyclohexane prior to analysis by GC/MS.

For the analysis of deltamethrin, a 1 g ENVI-Carb cartridge was conditioned with one volume of

dichloromethane, one volume of acetonitrile, and one volume of acetonitrile: water (4:1 v/v). A 10 mL aliquot of the total extract from the sediment that totalled 700 mL was passed through the cartridge. The cartridge was rinsed with acetonitrile: water (3:2, v/v) and methanol prior to eluting with dichloromethane. 86 µL of a 0.06 µg/mL deltamethrin-phenoxy-¹³C₆ internal standard was added. The sample was evaporated at 40°C and reconstituted in 3-4 mL of methanol: water (9:1, v/v) and transferred to an HPLC vial for analysis via MS/MS.

Derivatization Method: Not employed.

Identification and Quantification of Parent Compound: For the analysis of all analytes but deltamethrin, GC/MS was utilized for the identification and quantification. A 30-m capillary RTX-5MS, 5% phenyl methyl syloxane column, initial temperature 80°C with two ramps up to 280°C, with helium carrier gas, was optimized and used. The injection volume was 2 µL. The MS detector was monitored as shown in the following table (page 108). Calibration curves were prepared for each analyte, samples were calculated with mass spectra (MS), and measurements were based on the isotopic peak area ratio. A regression was done using a series of calibration standards.

Chemicals in Group 1	Ion Monitored	Retention Time (min)	Chemicals in Group 2	Ion Monitored	Retention Time (min)
Bifenthrin	386	19.8	Bifenthrin	386	19.8
Gamma-cyhalothrin	241	21.6	Fenpropathrin	141	20.2
Beta-cyfluthrin	207	24.5	Lambda-cyhalothrin	241	21.6
Zeta-cypermethrin	207	25.2	Permethrin	207	23.4
Esfenvalerate	211	27.0	Cyfluthrin	207	24.5
Cyfluthrin-methyl-d6	213	24.5	Cypermethrin	207	25.2
			Cyfluthrin-methyl-d6	213	24.5

Data were obtained from pp. 107-108 of study report.

For deltamethrin, a Gemini HPLC column (50 x 2 mm, 5 µm) at 40°C, a flow rate of 0.200 mL/min, and a Leap Technologies PAL HTS autosampler were used. Each run lasted 8.0 minutes and the retention time for deltamethrin and deltamethrin-phenoxy-¹³C₆ was 1.3 minutes (although it was reported to be 3.0 min in the open literature publication's supplemental information). The organic phase solvent was methanol, while the aqueous phase consisted of methanol: water (9:1, v/v), containing 10 mM ammonium acetate. The carrier contained 10% aqueous solvent and 90% organic phase solvent from 0 to 6.0 minutes (page 109). Sample concentrations were measured with a MS/MS and measurements were based on the native area to isotopic peak area ratio. A regression was done using a series of calibration standards.

QC samples of the test compounds at 5 and 50 ppb (10 and 100% of the amount applied) were tested concurrent with the study samples. The QC was determined to be acceptable if the recoveries of the QC samples were between 70 and 120% of the amount applied, and the correlation coefficient of the calibration curve was greater than 0.98.

Detection Limits (LOD, LOQ) for the Parent Pyrethroid Compounds: The limit of detection (LOD) ranged from 0.2 to 1.4 ppb or 0.4 to 2.8% of the applied amount; the limit of quantitation (LOQ) was set to 5 ppb, which was the lowest spiked level tested (10% of the applied amount). It was indicated that the detector response was linear from 2.5 to 100 ppb sample equivalents,

except for deltamethrin (4 to 100 ppb sample equivalents) (page 20 of study report).

II. Results and Discussion

A. Data:

Study results are presented in **Tables 8a to 8f**. During the course of the aerobic aquatic studies, the oxygen content in the water was ≥ 5.3 mg/L (sediment 1), ≥ 4.5 mg/L (sediment 2), and ≥ 4.9 mg/L (sediment 3). During the course of the anaerobic aquatic studies, the oxygen content in the water was ≤ 0.4 mg/L (all sediments). pE + pH was kept below 12 units for all the anaerobic aquatic studies (refer to the attachment) (pp. 27-28 of study report).

B. Mass Balance:

The method was validated by fresh spiking each of the sediments with 5 and 50 ppb of each test substance (LOQ and 10 LOQ or 10% and 100% of the applied amount) during the test. Mean recoveries were reported to be 72-106% of the applied amount and relative standard deviations were $\leq 13\%$ in all instances. Values were means of 5 replicates of each spiking level, except for sediment 3, spiked at 50 ppb, for which 4 replicates were obtained for test mixture 1 (Table 7, p. 30 of study report). Raw data for the above results were not provided.

Material balance was not determined. At each test interval, one concurrent recovery of each of the chemicals was run in each of the sediments. Results ranged from 71% of the applied amount (*gamma*-cyhalothrin at 14 days posttreatment in sediment 1) to 114%, with the exception of 122% of the applied amount for a single sample of fenpropathrin at 0 days posttreatment in the aerobic sediment 2 and one sample of bifenthrin that had a recovery of 65% of the applied amount for the aerobic sediment 1, day 0. A total of 504 concurrent recoveries were obtained (Tables 8-11, pp. 31-34 of study report). Since the overall recovery was reported to be close to 96% of the applied amount, results were not corrected for concurrent recoveries.

C. Bound and Extractable Residues:

The amount of extractable radioactivity declined as shown for each independent pyrethroid with variable rates. Unextracted residues were not determined since no radiolabeled compounds were used.

D. Volatilization:

Volatiles were not trapped.

Table 8a. Degradation of Eleven Synthetic Pyrethroids in Water:Sediment System 1, Under Aerobic Condition, Expressed as a Percentage of the Theoretical Applied Amount

Sampling Interval (days)	0		3		7		14		28		59		100	
Replicate Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bifenthrin (1)	99	94	76	83	85	75	67	66	64	72	69	55	46	41
Bifenthrin (2)	112	108	93	97	88	92	77	75	79	84	73	74	36	55
<i>Beta</i> -cyfluthrin	97	95	44	47	31	28	15	11	11	(9)	(9)	(7)	(5)	(4)
Cyfluthrin	97	91	56	57	34	33	15	15	13	14	(9)	(6)	(5)	(8)
<i>Gamma</i> -cyhalothrin	97	92	79	85	72	63	34	26	35	28	27	22	12	(9)
<i>Lambda</i> -cyhalothrin	102	97	90	100	68	74	34	46	45	43	32	28	14	24
<i>Zeta</i> -cypermethrin	93	88	51	56	36	30	15	13	13	11	11	(10)	(7)	(5)
Cypermethrin	95	94	52	55	27	25	13	12	(10)	11	(7)	(4)	(4)	(6)
Deltamethrin	103	98	87	89	65	60	35	37	26	20	18	20	(8)	(4)
Esfenvalerate	93	89	79	85	69	60	40	36	29	24	31	25	16	11
Fenpropathrin	99	97	73	78	48	51	30	26	24	23	16	14	(8)	12
Permethrin	96	94	42	45	19	20	13	(10)	(9)	(10)	(3)	(3)	(5)	(6)

Data were obtained from pp. 35 (Table 12) and 38 (Table 13) of the study report. Values in (parenthesis) are readings below the LOQ. LOQ is 10% of the theoretical applied amount.

Table 8b. Degradation of Eleven Synthetic Pyrethroids in Water:Sediment System 2, Under Aerobic Condition, Expressed as a Percentage of the Theoretical Applied Amount

Sampling Interval (days)	0		3		7		14		28		60		103	
Replicate Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bifenthrin (1)	81	72	94	100	88	90	94	99	94	86	93	100	70	68
Bifenthrin (2)	76	76	111	112	95	89	86	83	83	86	77	81	74	69
<i>Beta</i> -cyfluthrin	94	98	63	71	54	50	32	37	27	26	14	15	(9)	(9)
Cyfluthrin	96	97	71	74	57	55	44	44	29	34	21	19	12	11
<i>Gamma</i> -cyhalothrin	89	88	85	94	87	83	69	78	60	57	40	47	27	28
<i>Lambda</i> -cyhalothrin	88	89	94	95	85	79	61	71	57	65	50	48	32	24
<i>Zeta</i> -cypermethrin	96	100	74	80	64	62	44	49	35	35	21	24	13	14
Cypermethrin	98	100	73	73	58	51	40	40	25	30	19	18	(9)	(9)
Deltamethrin	94	98	90	96	88	91	65	73	56	54	36	39	27	26
Esfenvalerate	98	103	87	93	84	88	64	64	61	58	40	42	28	30
Fenpropathrin	86	87	97	98	84	77	69	69	59	64	53	57	26	25
Permethrin	93	96	84	79	70	62	62	60	50	55	44	42	24	25

Data were obtained from pp. 36 (Table 12) and 39 (Table 13) of the study report. Values in (parenthesis) are readings below the LOQ. LOQ is 10% of the theoretical applied amount.

Table 8c. Degradation of Eleven Synthetic Pyrethroids in Water:Sediment System 3, Under Aerobic Condition, Expressed as a Percentage of the Theoretical Applied Amount

Sampling Interval (days)	0		3		7		14		28		58		100	
Replicate Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bifenthrin (1)	90	98	78	78	79	81	80	88	72	81	69	74	16	65
Bifenthrin (2)	95	94	84	87	87	90	79	81	86	83	77	47	45	27
<i>Beta</i> -cyfluthrin	93	95	47	40	25	25	14	23	11	10	(6)	(4)	(3)	(7)
Cyfluthrin	93	95	49	43	30	26	19	13	11	(7)	(5)	(2)	(4)	(1)
<i>Gamma</i> -cyhalothrin	96	105	76	75	55	60	45	62	40	36	21	21	(2)	16
<i>Lambda</i> -cyhalothrin	98	100	74	77	65	66	48	45	36	28	26	(7)	(5)	(2)
<i>Zeta</i> -cypermethrin	92	93	56	52	32	34	17	30	14	15	(9)	(6)	(2)	(6)
Cypermethrin	91	95	43	42	25	20	15	11	(8)	(5)	(5)	(2)	(3)	(1)
Deltamethrin	102	103	72	80	53	58	35	51	32	27	19	14	(8)	14
Esfenvalerate	96	102	80	81	66	69	59	69	43	37	26	19	(3)	20
Fenpropathrin	93	92	70	62	54	39	29	22	29	14	13	(5)	(2)	(1)
Permethrin	104	96	48	40	24	16	14	12	15	11	(5)	(2)	(2)	(2)

Data were obtained from pp. 37 (Table 12) and 40 (Table 13) of the study report. Values in (parenthesis) are readings below the LOQ. LOQ is 10% of the theoretical applied amount.

Table 8d. Degradation of Eleven Synthetic Pyrethroids in Water:Sediment System 1, Under Anae robic Condition, Expressed as a Percentage of the Theoretical Applied Amount

Sampling Interval (days)	0		3		11		19		28		60		101	
Replicate Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bifenthrin (1)	92	100	99	89	92	96	86	90	95	99	80	101	96	80
Bifenthrin (2)	91	87	97	99	92	96	84	88	86	87	99	112	80	92
<i>Beta</i> -cyfluthrin	94	97	57	57	51	51	48	39	32	48	22	23	21	15
Cyfluthrin	97	92	76	82	84	87	48	43	36	33	25	24	18	24
<i>Gamma</i> -cyhalothrin	98	103	97	93	81	85	84	79	71	79	58	64	58	43
<i>Lambda</i> -cyhalothrin	96	99	92	95	60	63	75	80	70	66	52	57	40	54
<i>Zeta</i> -cypermethrin	93	94	74	72	60	63	-- ^a	49	44	59	31	35	30	23
Cypermethrin	95	96	76	80	87	87	-- ^a	43	35	31	24	25	17	23
Deltamethrin	102	100	90	91	87	87	-- ^a	73	71	80	55	63	53 ^b	46 ^b
Esfenvalerate	96	96	97	90	84	87	-- ^a	73	70	76	52	57	55	47
Fenpropathrin	97	99	91	91	51	51	-- ^a	72	66	65	50	50	48	53
Permethrin	93	97	82	86	81	85	-- ^a	63	59	54	58	62	33	55

Data were obtained from pp. 41 (Table 14) and 44 (Table 15) of the study report. Values in (parenthesis) are readings below the LOQ. LOQ is 10% of the theoretical applied amount.

^a The registrant discarded this data due to high variance from the degradation curve.

^b This sampling occurred at 108 days post treatment.

Table 8e. Degradation of Eleven Synthetic Pyrethroids in Water:Sediment System 2, Under Anae robic Condition, Expressed as a Percentage of the Theoretical Applied Amount

Sampling Interval (days)	0		3		7		14		28		61		104	
Replicate Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bifenthrin (1)	70	75	76	79	74	74	81	79	94	86	74	76	60	55
Bifenthrin (2)	78	80	69	75	76	78	81	73	83	86	75	78	51	55
<i>Beta</i> -cyfluthrin	90	92	85	85	71	69	68	64	27	26	16	22	11	(10)
Cyfluthrin	96	98	88	87	78	81	68	64	29	34	29	26	15	15
<i>Gamma</i> -cyhalothrin	76	85	82	97	90	88	103	97	60	57	52	64	50	44
<i>Lambda</i> -cyhalothrin	93	92	88	88	92	93	89	93	57	65	62	61	43	46
<i>Zeta</i> -cypermethrin	90	95	87	91	83	81	78	69	35	35	25	32	21	19
Cypermethrin	95	96	86	87	79	80	67	62	25	30	29	26	13	12
Deltamethrin	98	99	102	98	98	93	91	93	56	54	46	56	46	43
Esfenvalerate	91	94	91	95	92	87	97	92	61	58	45	56	42	39
Fenpropathrin	83	85	78	84	81	82	88	82	59	64	62	64	41	47
Permethrin	94	99	86	97	90	91	90	84	50	55	49	51	37	38

Data were obtained from pp. 42 (Table 14) and 45 (Table 15) of the study report. Values in (parenthesis) are readings below the LOQ. LOQ is 10% of the theoretical applied amount.

Table 8f. Degradation of Eleven Synthetic Pyrethroids in Water:Sediment System 3, Under Anae robic Condition, Expressed as a Percentage of the Theoretical Applied Amount

Sampling Interval (days)	0		3		7		14		28		59		100	
Replicate Number	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Bifenthrin (1)	81	80	71	72	81	81	70	67	86	94	71	63	58	64
Bifenthrin (2)	78	76	75	77	81	79	76	75	83	83	63	64	60	63
<i>Beta</i> -cyfluthrin	96	94	78	80	72	74	46	50	39	40	17	15	(8)	(8)
Cyfluthrin	96	95	82	89	71	70	53	51	35	35	20	17	(7)	(10)
<i>Gamma</i> -cyhalothrin	103	91	93	96	89	90	85	85	81	82	60	56	31	35
<i>Lambda</i> -cyhalothrin	100	87	84	96	87	81	84	70	68	69	47	54	24	33
<i>Zeta</i> -cypermethrin	96	94	86	87	79	82	65	64	53	55	30	28	14	16
Cypermethrin	99	97	88	90	73	70	54	54	36	37	19	17	(7)	(9)
Deltamethrin	103	100	96	95	91	92	79	81	77	74	52	51	28	31
Esfenvalerate	103	99	88	91	92	93	86	81	68	74	55	55	33	34
Fenpropathrin	87	85	86	87	81	79	70	67	74	77	58	61	30	45
Permethrin	96	94	90	96	91	93	81	78	73	69	54	52	26	40

Data were obtained from pp. 43 (Table 14) and 46 (Table 15) of the study report. Values in (parenthesis) are readings below the LOQ. LOQ is 10% of the theoretical applied amount.

E. Degradation of Test Compound:

For **Tables 9a to 9x**, degradation kinetics of eleven synthetic pyrethroids in the total aquatic systems, calculated half-lives and model parameters for the best fit kinetics models were in accordance with the NAFTA kinetics guidance (USEPA, 2011); they are shown in **RED** font. Kinetics models used are: Single First-Order (SFO); Double First-Order in Parallel (DFOP), and Indeterminate Order Rate Equation (IORE). Kinetic calculation results were obtained using the R program routine PestDFV.1.0 (PestDF stands for Pesticide Degradation Fit).

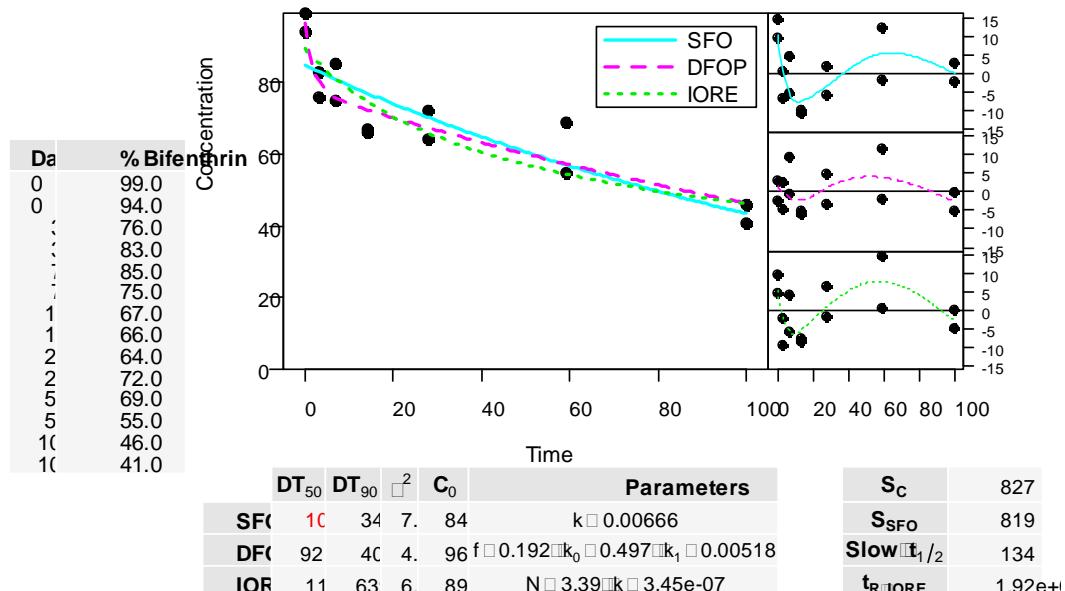
Degradation of eleven pyrethroids in sediments was highly variable, was dependent on the pyrethroid tested, and was usually faster under aerobic conditions, compared to anaerobic. In general, all chemicals were more persistent in Sediment 2. Sediment 2 was the one with the highest clay and organic carbon content. Bifenthrin appeared to be the most persistent of the pyrethroids tested. The calculated half-lives ranged from 2.05 days (*beta*-cyfluthrin in sediment 1) to 455 days (bifenthrin in sediment 2) aerobic; meanwhile, the range was from 17.1 days (cyfluthrin in sediment 3) to 9391 days (bifenthrin in sediment 1) anaerobic, as tabulated in **Tables 9a to 9x** (calculated half-lives and model parameters for the best fit kinetics models are in **RED** font). The SFO results were usually consistent or close to the SFO results reported in the study. The calculated DT₅₀s were usually similar to the observed DT₅₀s.

For *gamma*-cyhalothrin in sediment 3, SFO results were used as representative. The tool PestDFV1.0 yields a representative half-life of 40.7 days. Inspection of the data shows that the observed DT₅₀ is 59-100 days and the calculated DT₅₀ is 76.6 days using the tool-selected IORE model. Since the representative half-life does not appear to be conservative and the N value is negative, a half-life from the SFO model was selected in lieu of the model selected IORE.

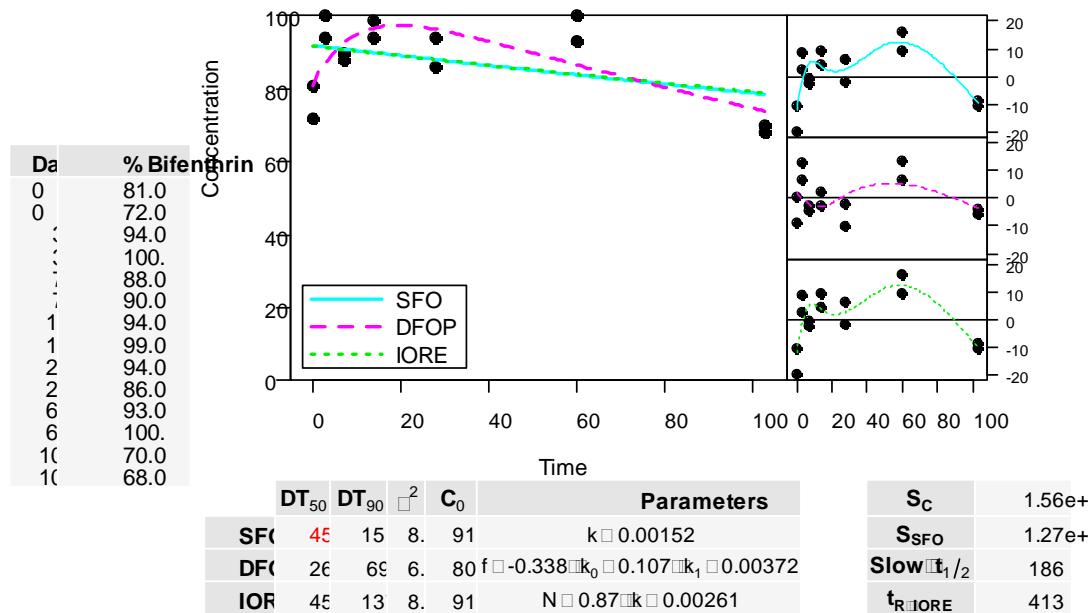
For esfenvalerate in sediment 1 SFO results were used as representative. Given that DFOP did not run in PestDFV1.0, the Excel Solver was used to fit the data. SFO was found to provide the best fit for the data (see the Attachment).

Table 9a. Degradation Kinetics of Bifenthrin (1) in Three Aquatic Systems, Under Aerobic Conditions^A

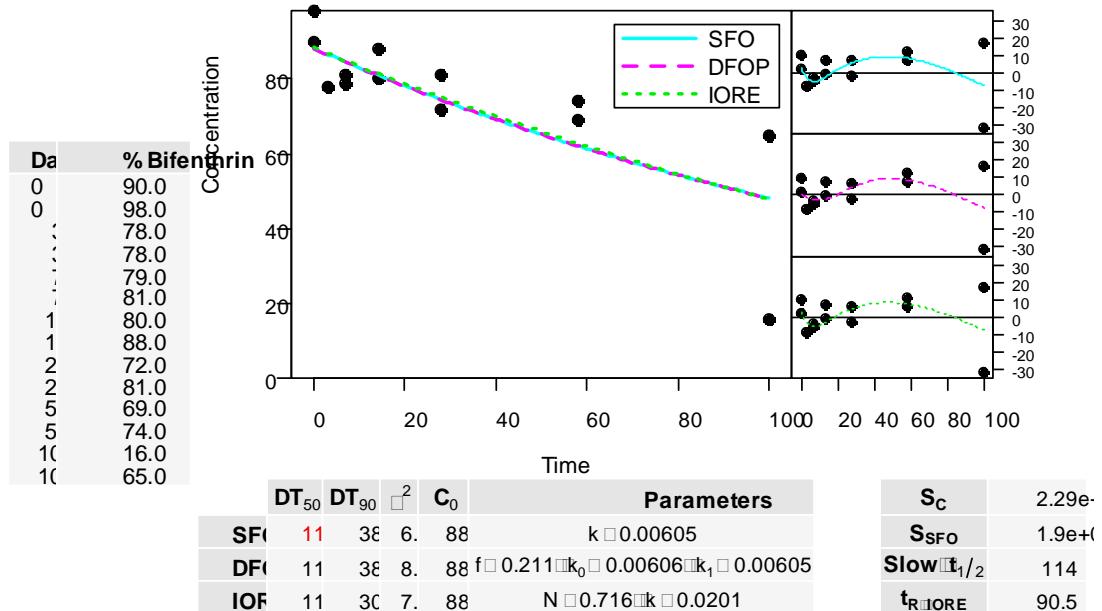
Aerobic Sediment 1, Test Mixture 1



Aerobic Sediment 2, Test Mixture 1



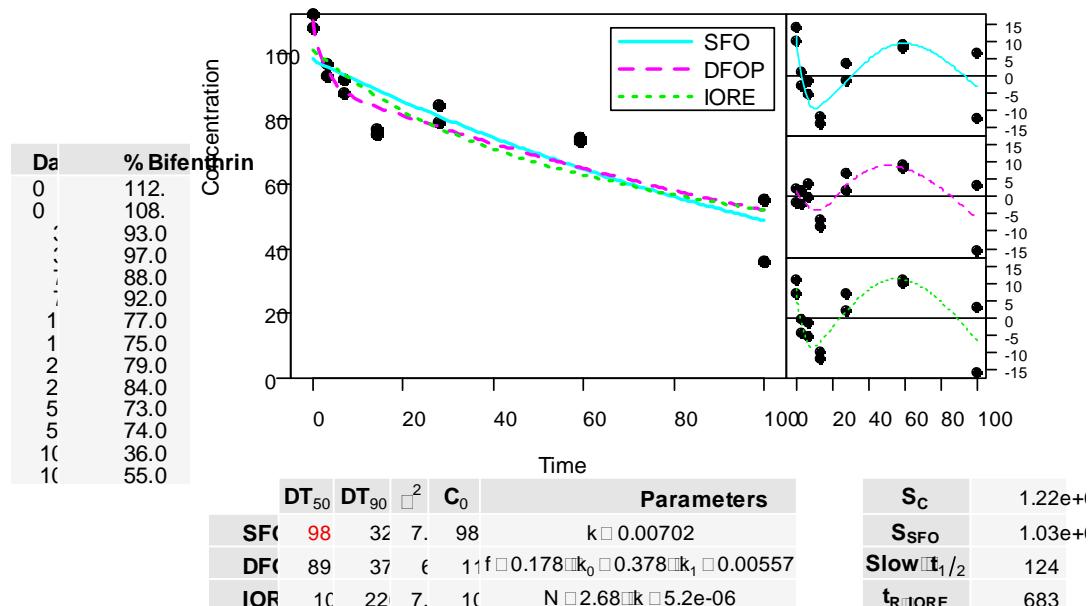
Aerobic Sediment 3, Test Mixture 1



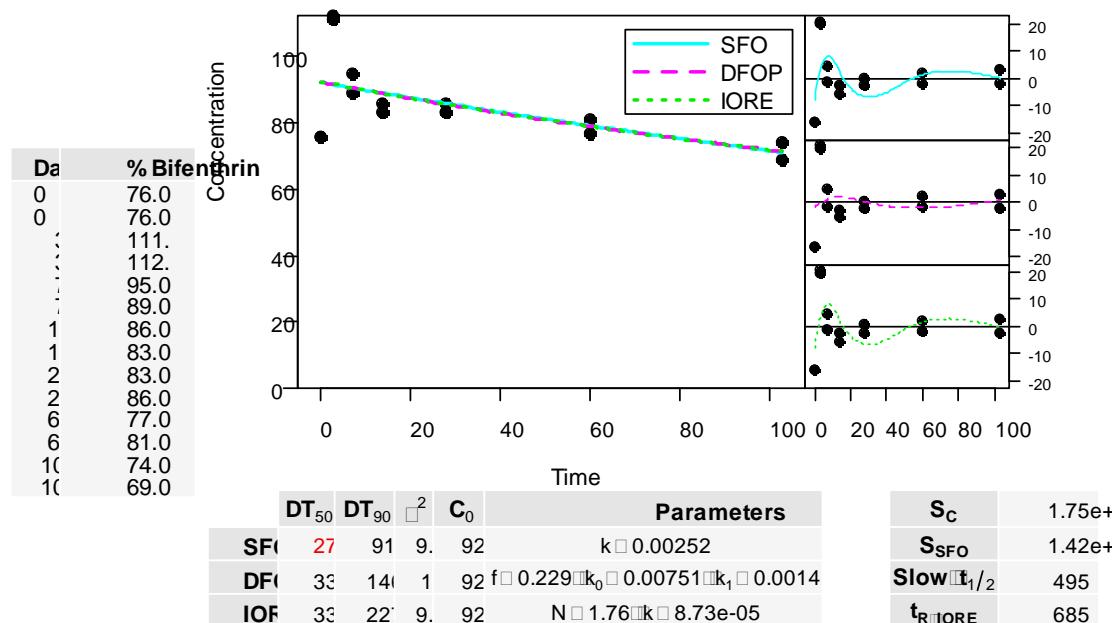
^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9b. Degradation Kinetics of Bifenthrin (2) in Three Aquatic Systems, Under Aerobic Conditions^A

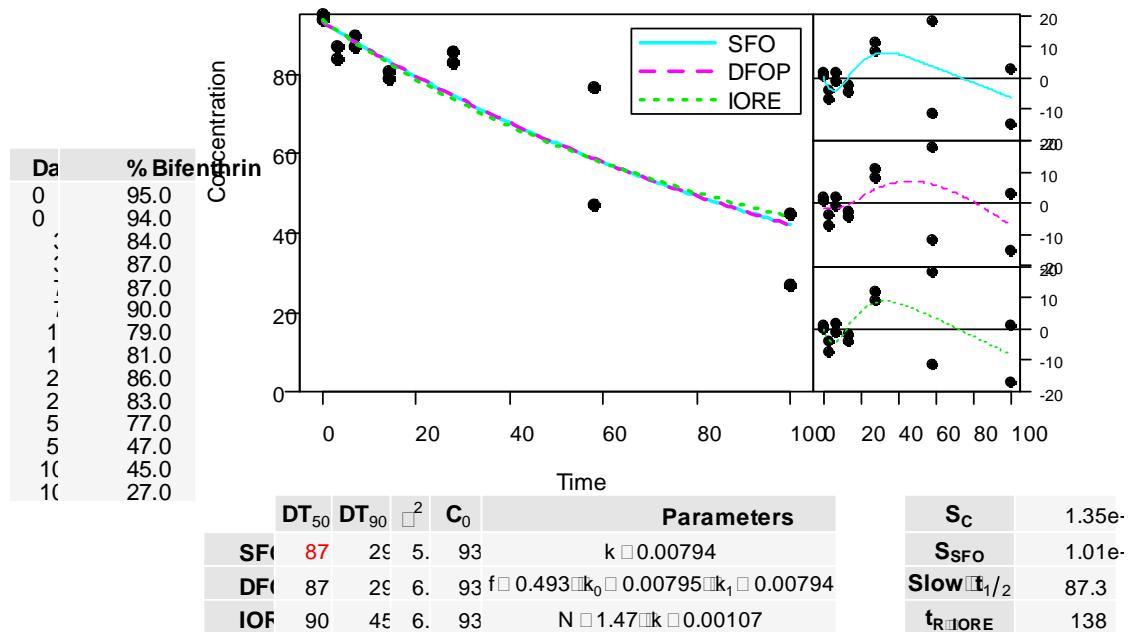
Aerobic Sediment 1, Test Mixture 2



Aerobic Sediment 2, Test Mixture 2



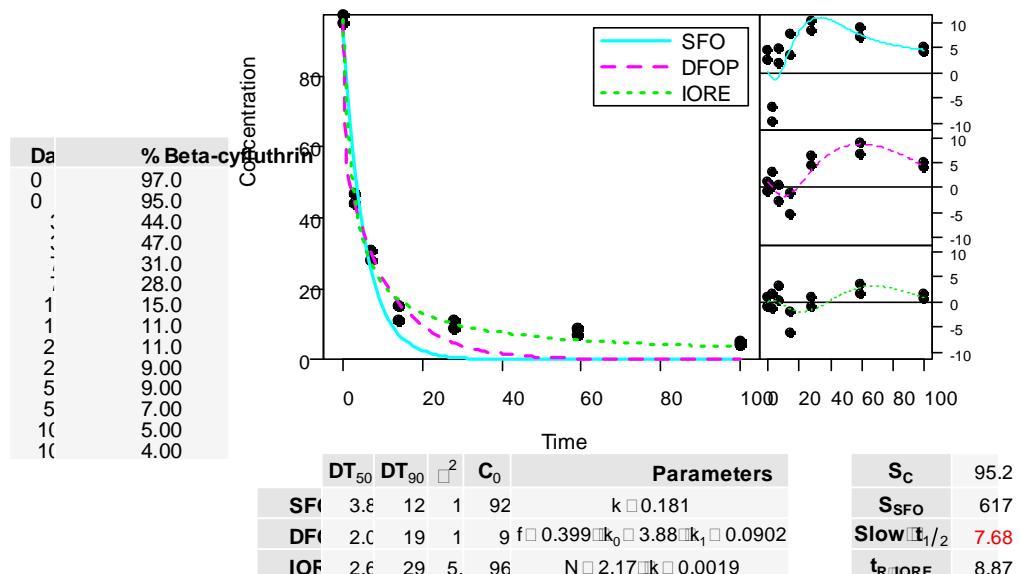
Aerobic Sediment 3, Test Mixture 2



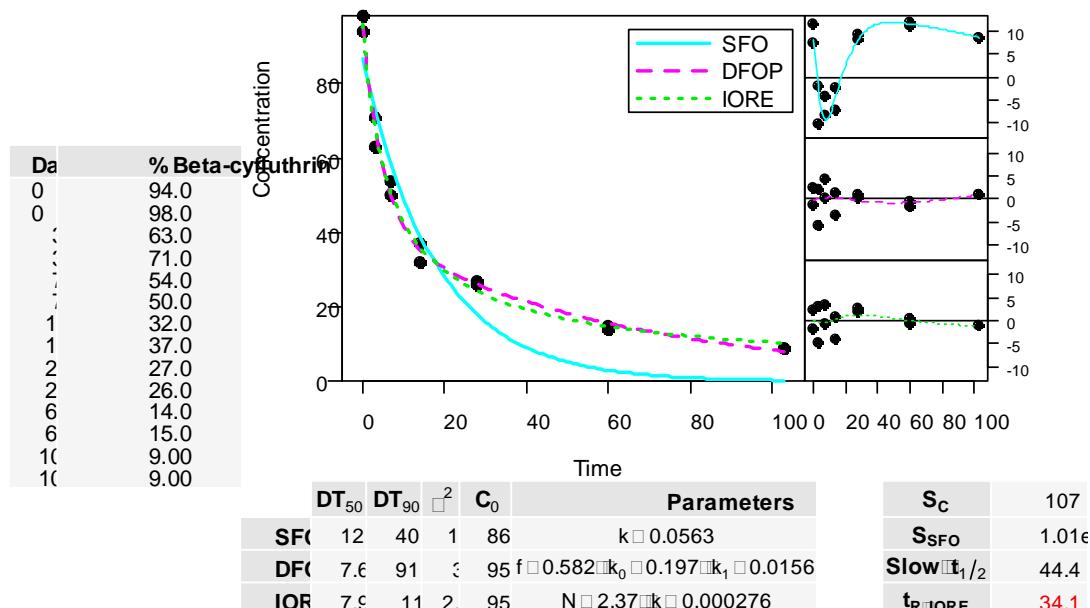
^A Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9c. Degradation Kinetics of Beta-cyfluthrin in Three Aquatic Systems, Under Aerobic Conditions ^A

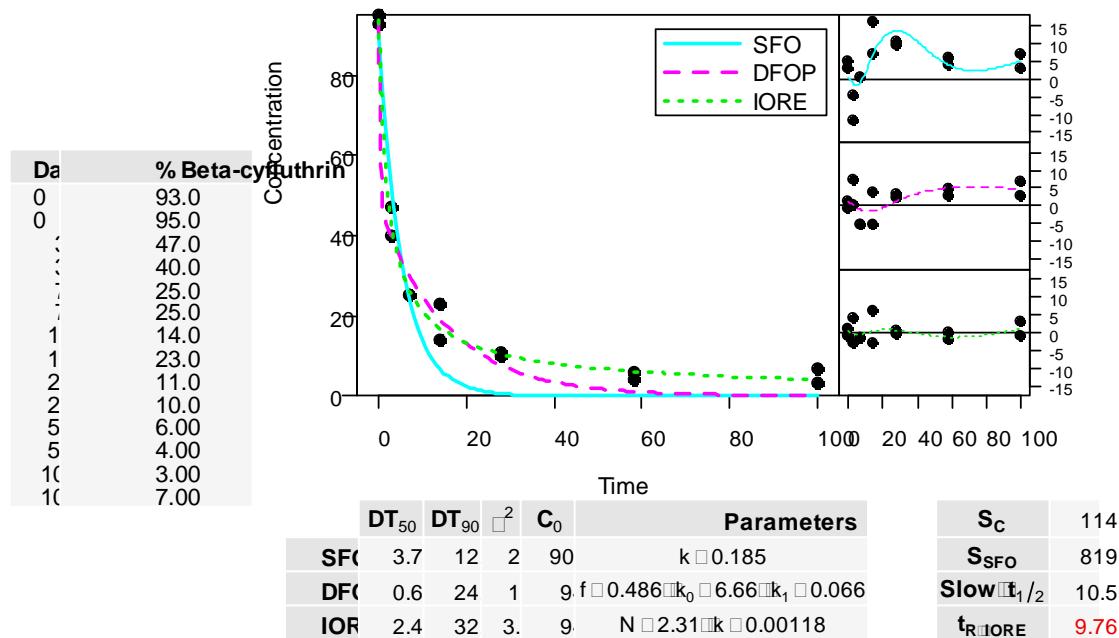
Aerobic Sediment 1



Aerobic Sediment 2



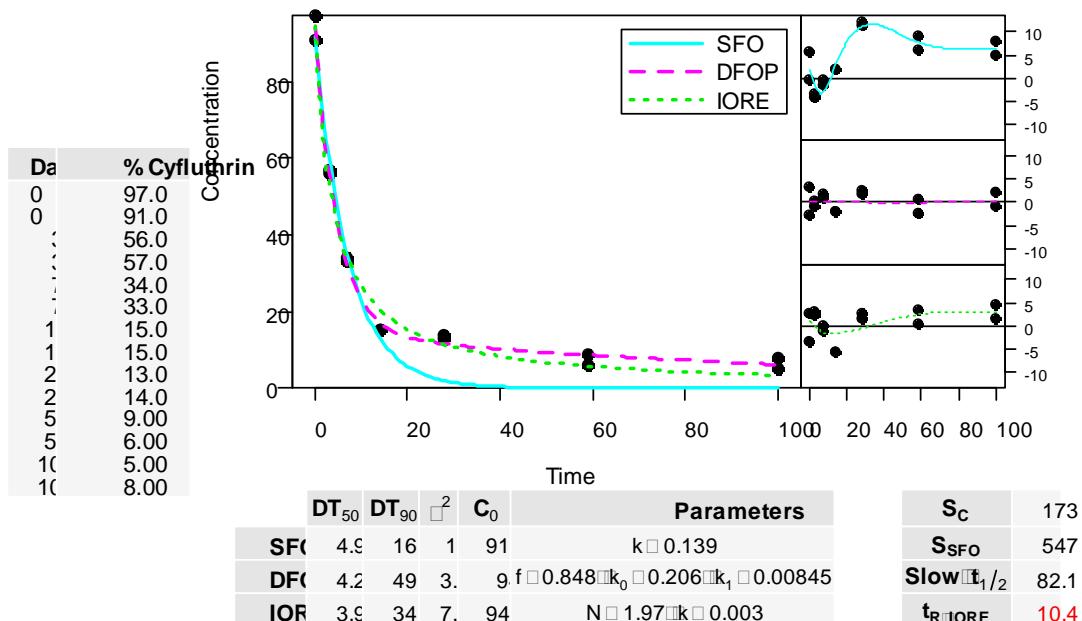
Aerobic Sediment 3



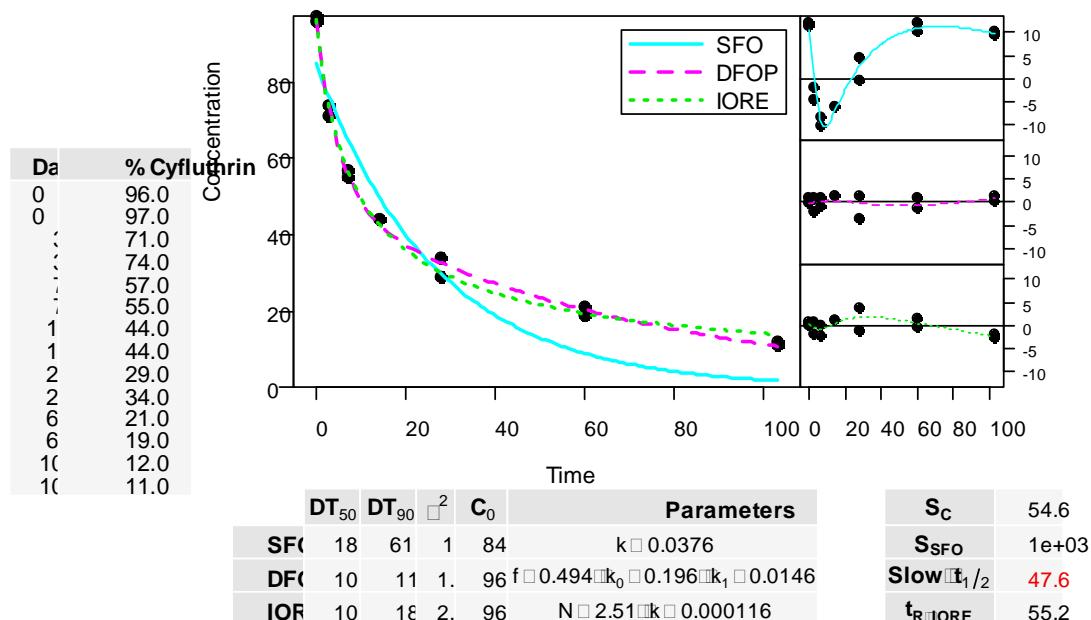
^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9d. Degradation Kinetics of Cyfluthrin in Three Aquatic Systems, Under Aerobic Conditions^A

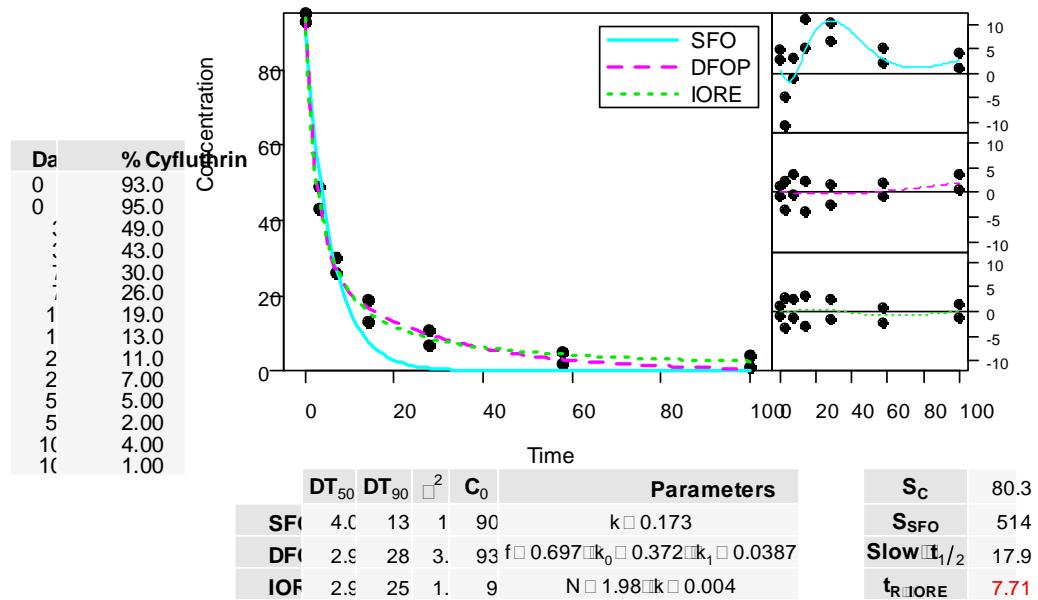
Aerobic Sediment 1



Aerobic Sediment 2



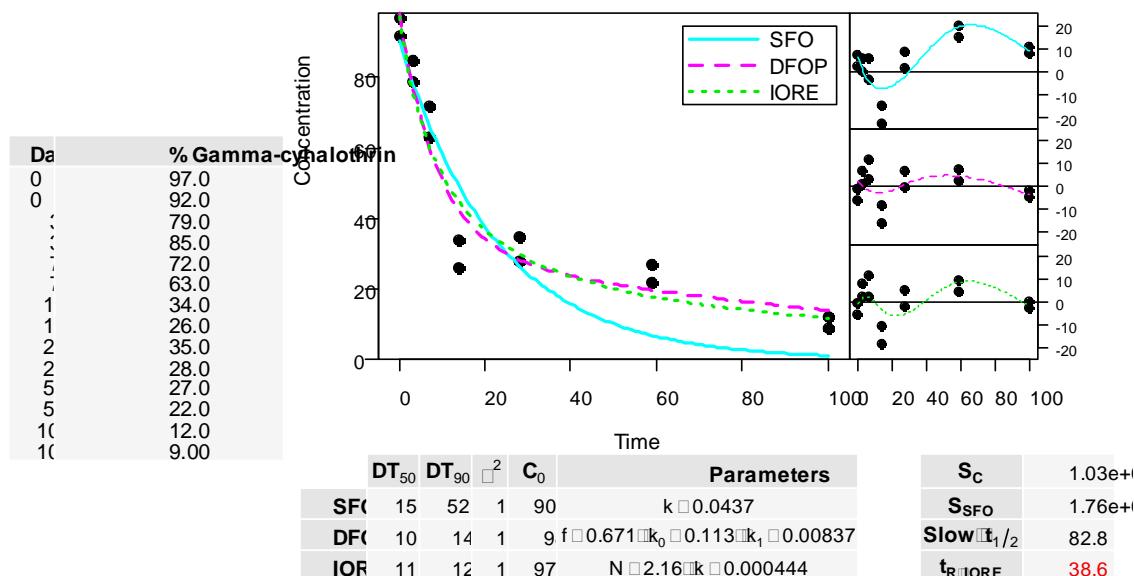
Aerobic Sediment 3



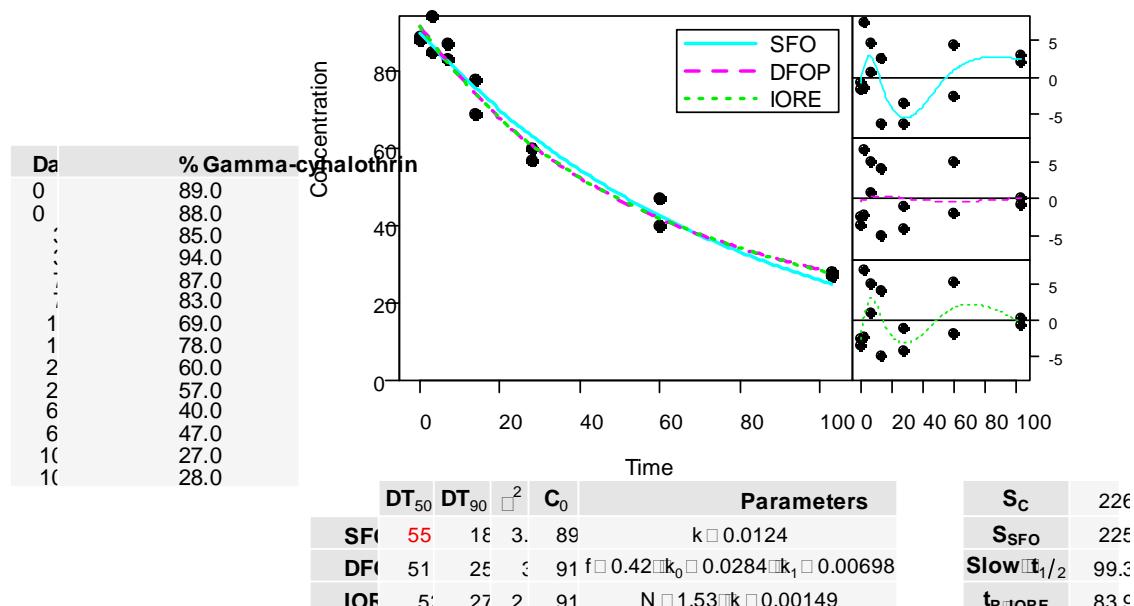
^A Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9e. Degradation Kinetics of *Gamma*-cyhalothrin in Three Aquatic Systems, Under Aerobic Conditions ^A

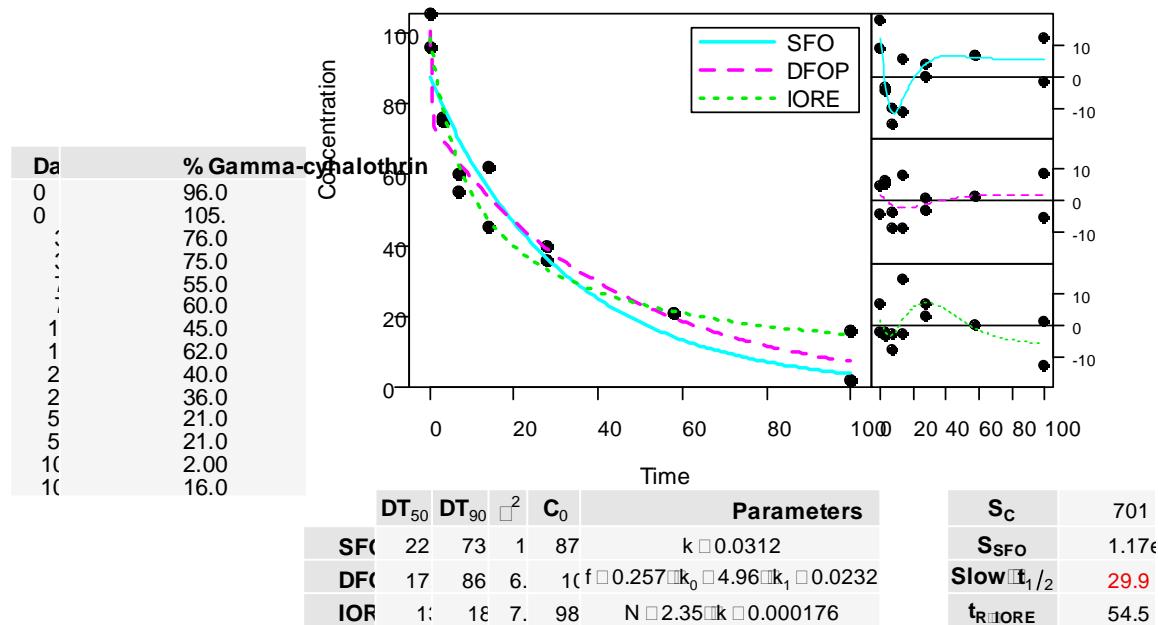
Aerobic Sediment 1



Aerobic Sediment 2



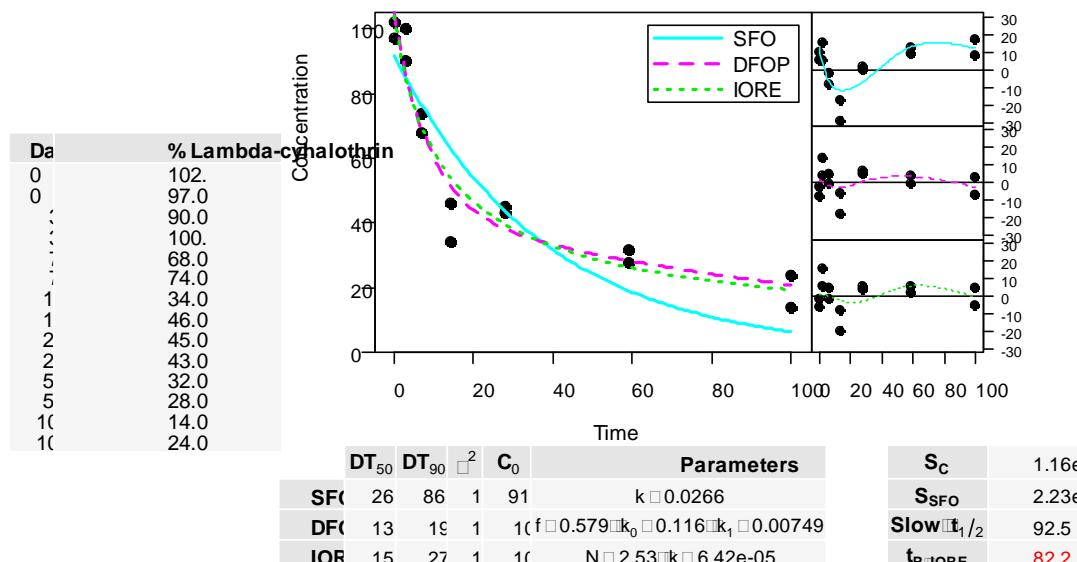
Aerobic Sediment 3



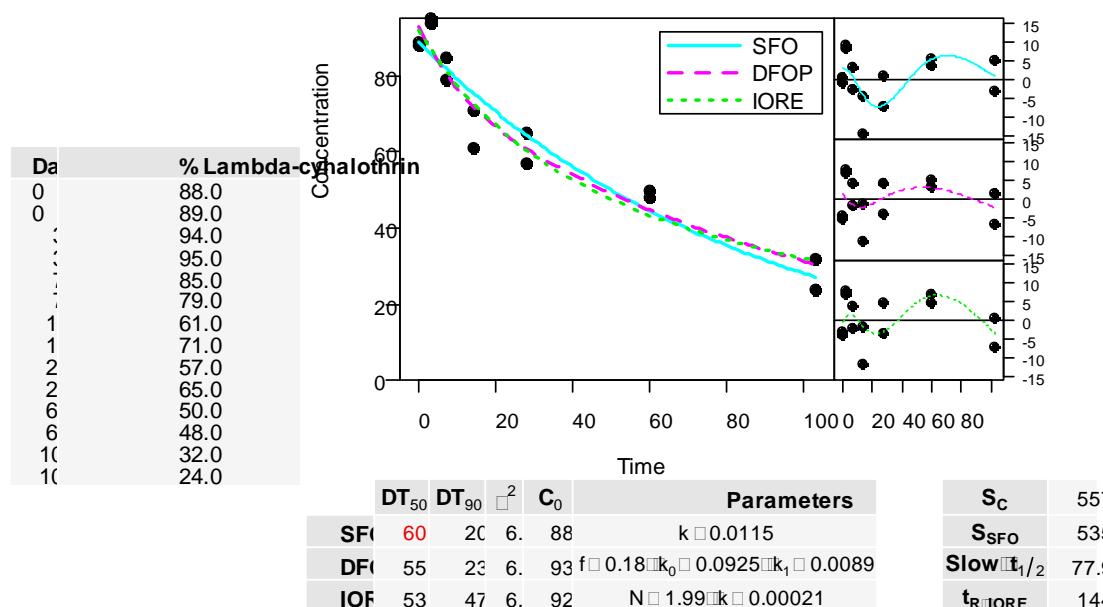
^A Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9f. Degradation Kinetics of Lambda-cyhalothrin in Three Aquatic Systems, Under Aerobic Conditions ^A

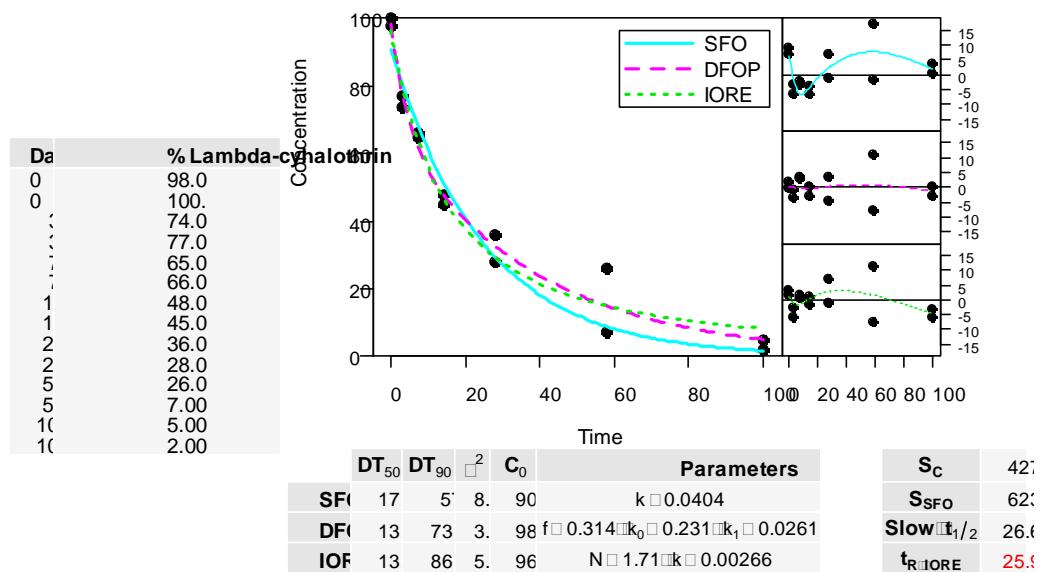
Aerobic Sediment 1



Aerobic Sediment 2



Aerobic Sediment 3

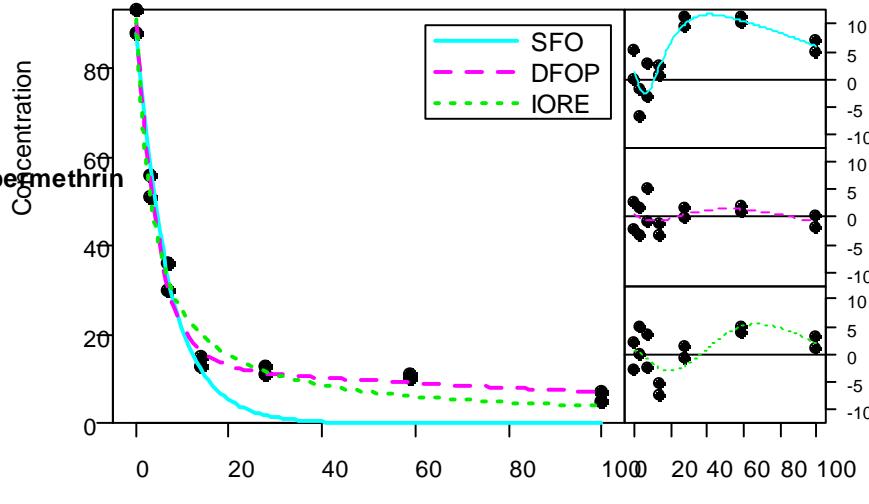


^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9g. Degradation Kinetics of Zeta-cypermethrin in Three Aquatic Systems, Under Aerobic Conditions ^A

Aerobic Sediment 1

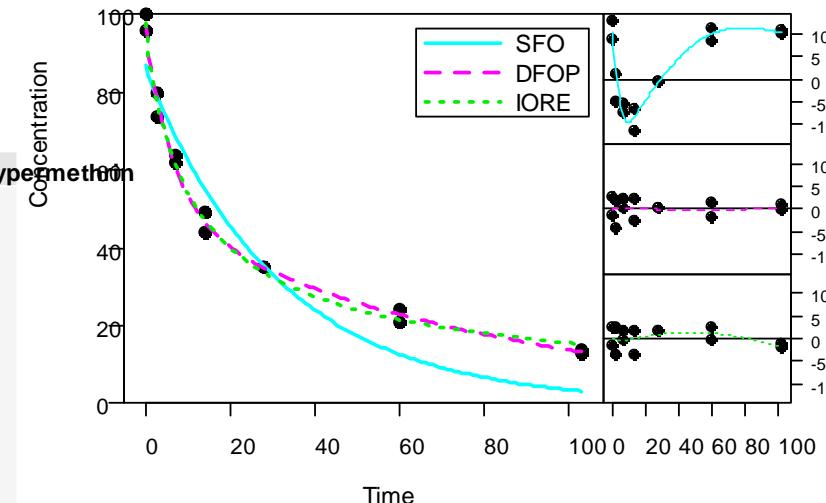
Da	% Zeta-cypermethrin
0	93.0
0	88.0
.	51.0
.	56.0
.	36.0
.	30.0
1	15.0
1	13.0
2	13.0
2	11.0
5	11.0
5	10.0
10	7.00
10	5.00



	DT ₅₀	DT ₉₀	$\frac{C_0}{2}$	C ₀	Parameters	S _c
SFO	4.9	16	1	8	k = 0.14	S _c = 230
DFOP	4.2	60	4.	90	f = 0.854, k ₀ = 0.206, k ₁ = 0.00635	S _{SFO} = 606
IORE	3.8	37	8.	9	N = 2.06, k = 0.00219	Slow t _{1/2} = 109, t _{RIORE} = 11.3

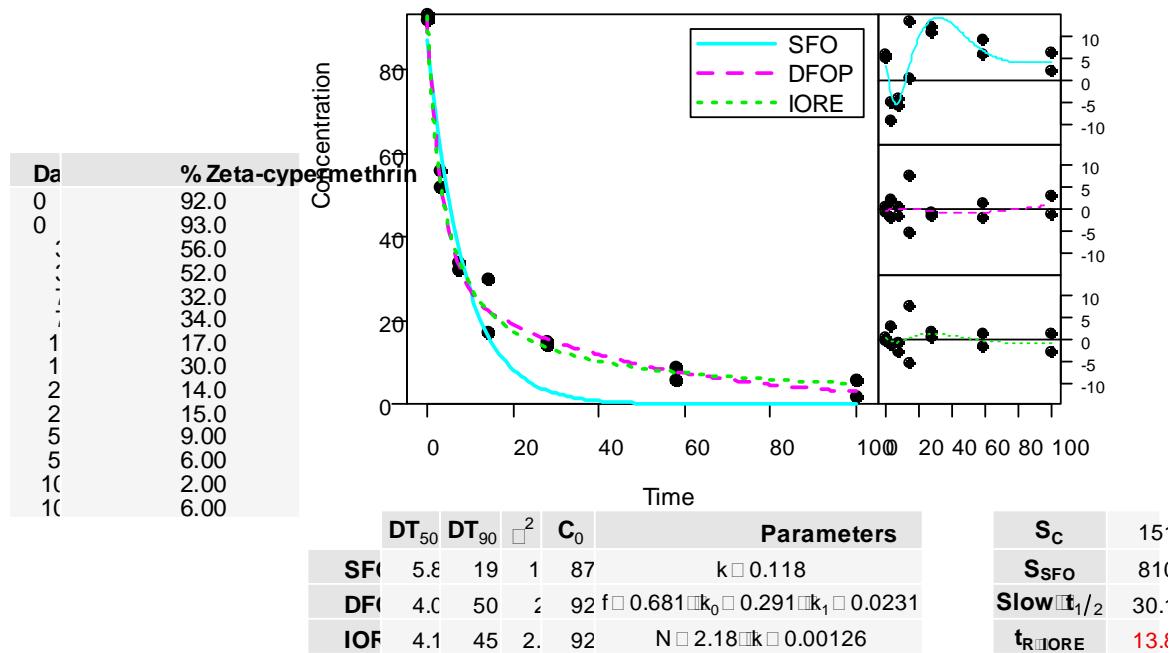
Aerobic Sediment 2

Da	% Zeta-cypermethrin
0	96.0
0	100.
.	74.0
.	80.0
.	64.0
1	62.0
1	44.0
2	49.0
2	35.0
6	35.0
6	21.0
10	24.0
10	13.0
10	14.0



	DT ₅₀	DT ₉₀	$\frac{C_0}{2}$	C ₀	Parameters	S _c
SFO	21	71	1	8	k = 0.0322	S _c = 76.1
DFOP	12	12	1.	97	f = 0.502, k ₀ = 0.148, k ₁ = 0.0126	S _{SFO} = 948
IORE	13	20	1.	97	N = 2.43, k = 0.000128	Slow t _{1/2} = 54.9, t _{RIORE} = 60.7

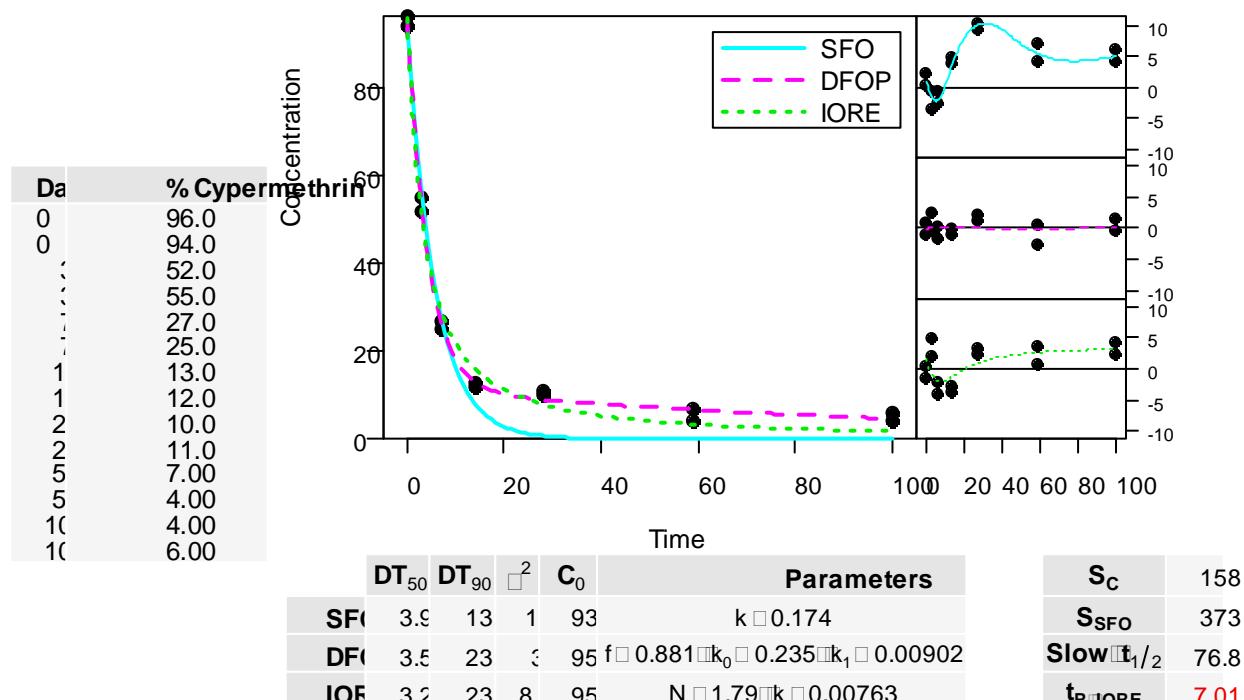
Aerobic Sediment 3



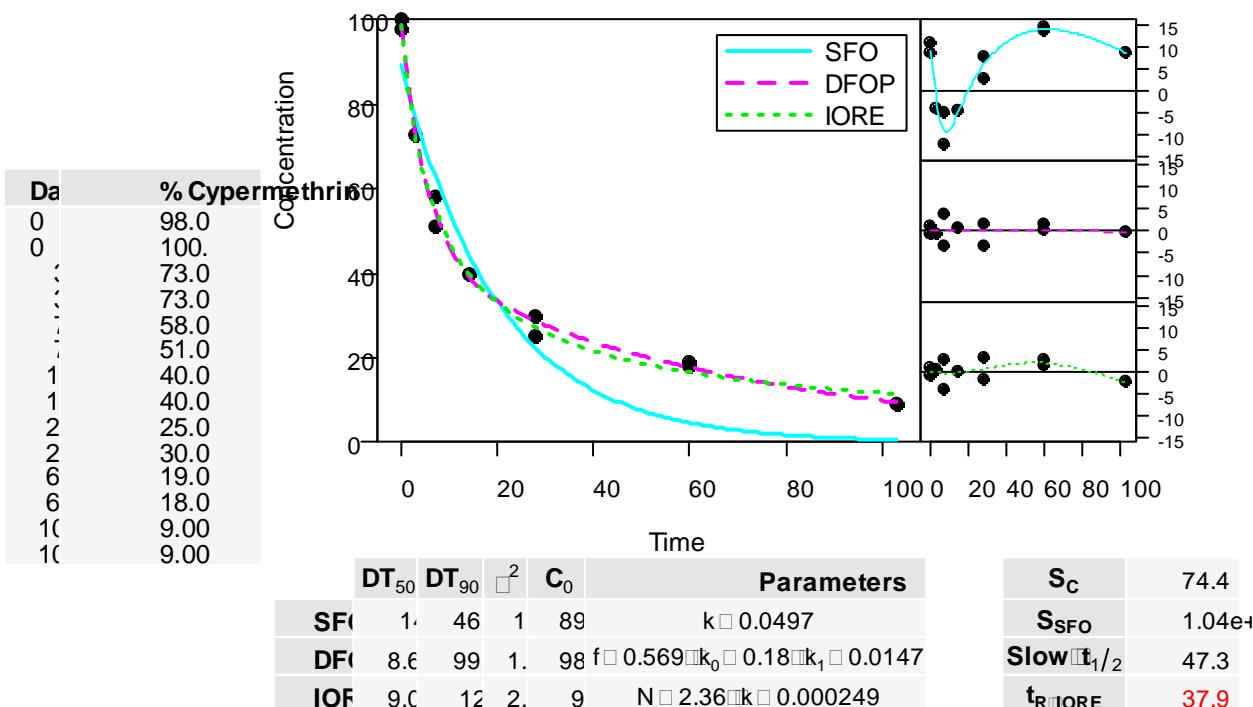
^A Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9h. Degradation Kinetics of Cypermethrin in Three Aquatic Systems, Under Aerobic Conditions ^A

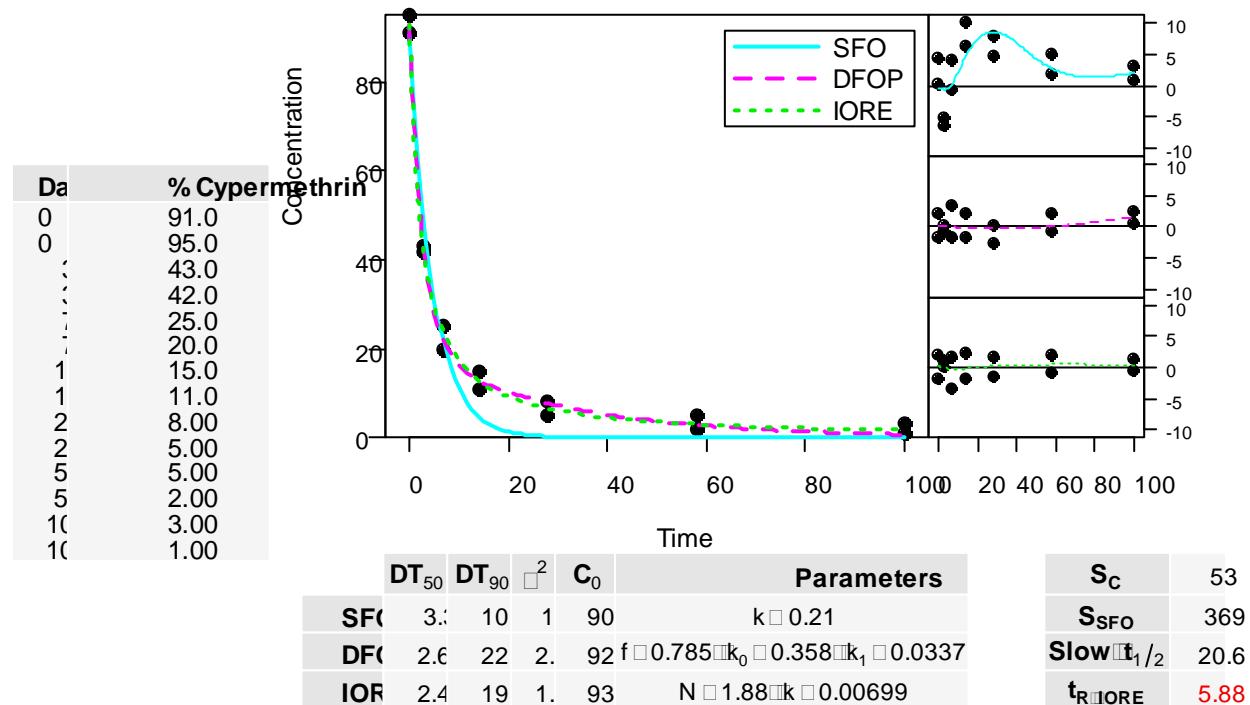
Aerobic Sediment 1



Aerobic Sediment 2



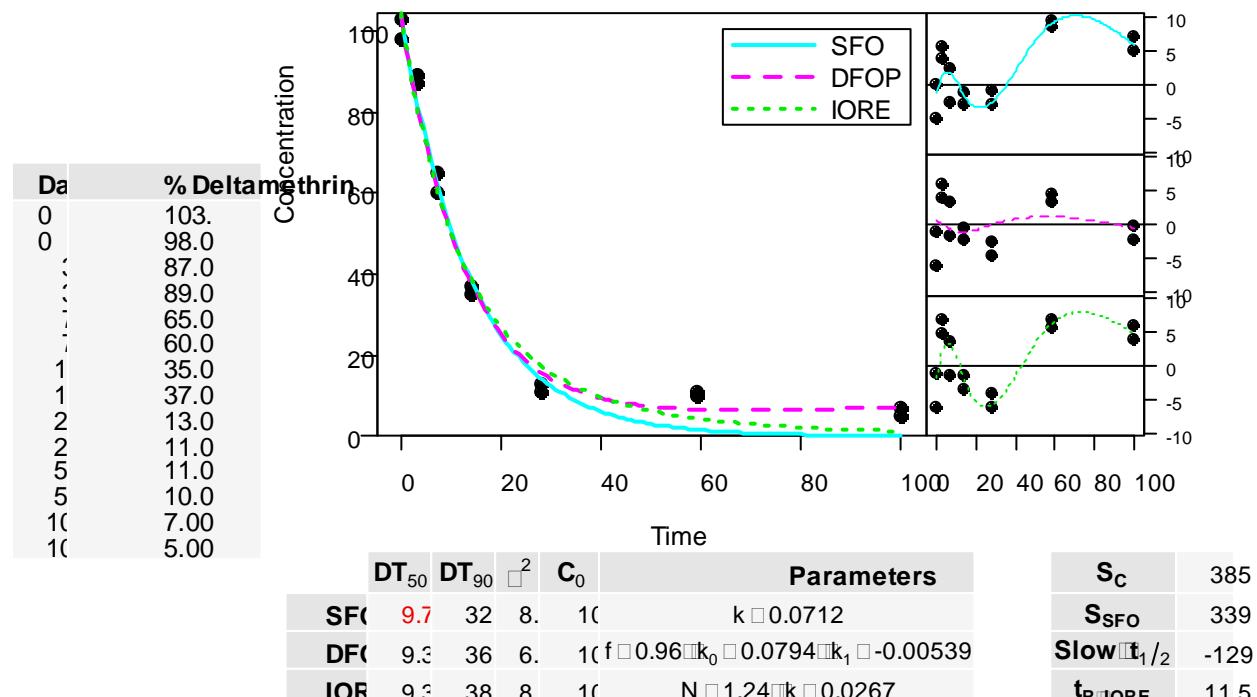
Aerobic Sediment 3



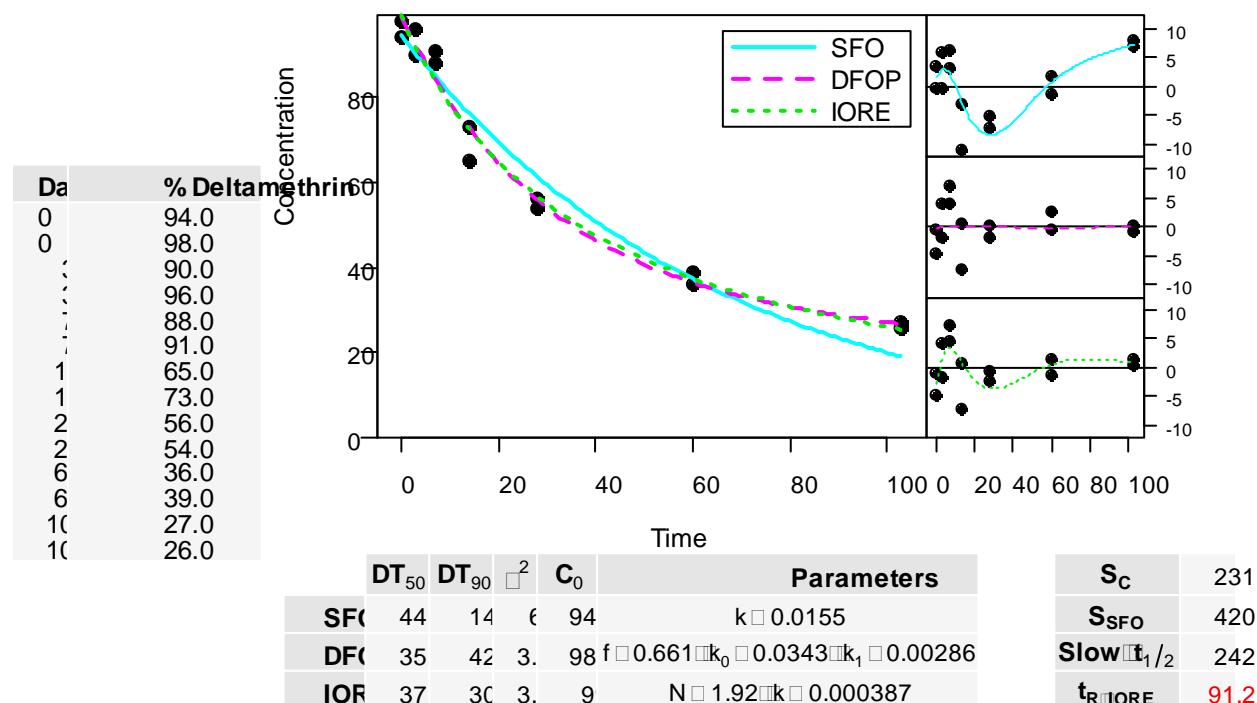
^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9i. Degradation Kinetics of Deltamethrin in Three Aquatic Systems, Under Aerobic Conditions^A

Aerobic Sediment 1

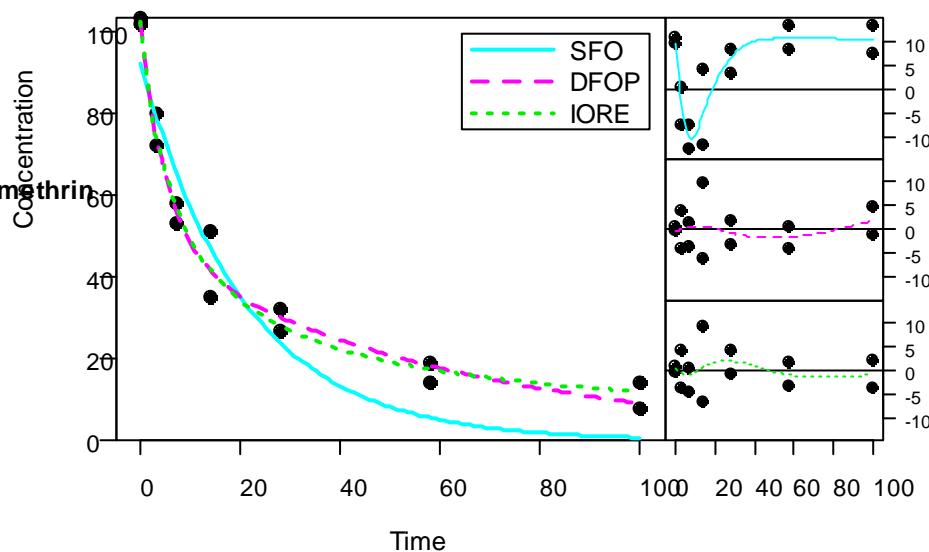


Aerobic Sediment 2



Aerobic Sediment 3

Da	% Deltamethrin
0	102.
0	103.
.	72.0
.	80.0
.	53.0
1	58.0
1	35.0
2	51.0
2	32.0
5	27.0
5	19.0
10	14.0
10	8.00
10	14.0

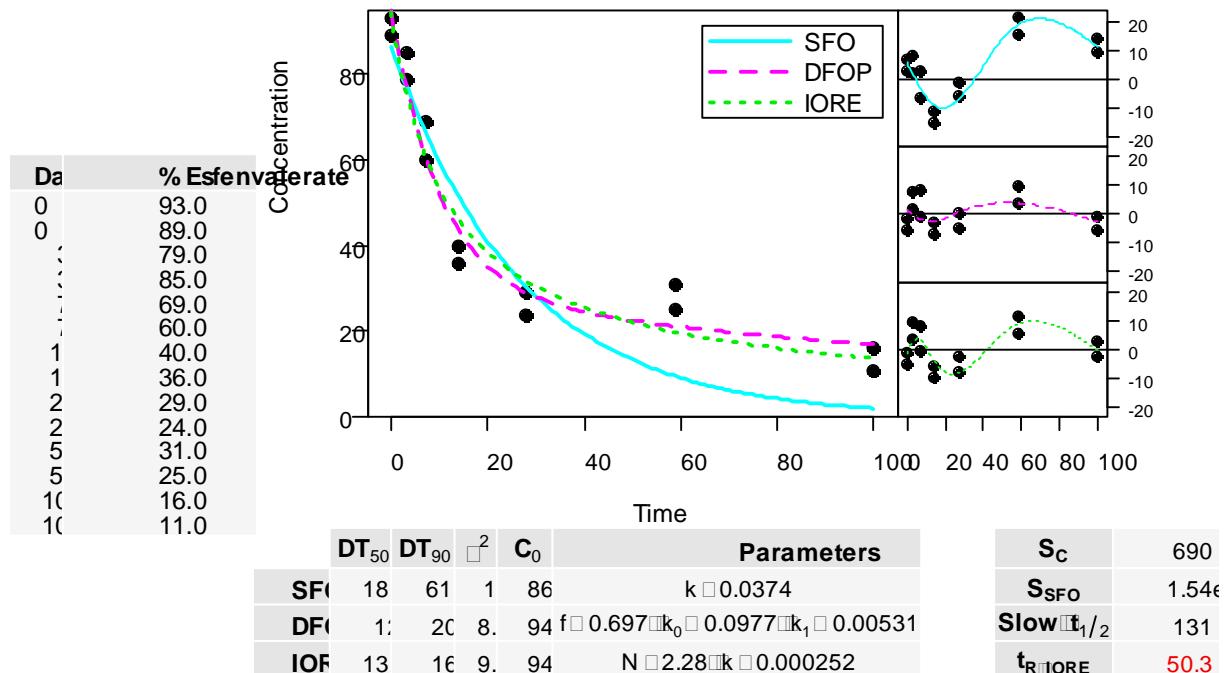


	DT ₅₀	DT ₉₀	R ²	C ₀	Parameters	S _c	
SFO	14	47	1	92	k = 0.0485	S _{sfo}	1.21e-
DFP	8.7	9.3	2.	10	f = 0.537, k ₀ = 0.193, k ₁ = 0.0165	Slow t _{1/2}	42.1
IOR	9.1	12	2.	10	N = 2.33, k = 0.000261	t _{RIORE}	37.3

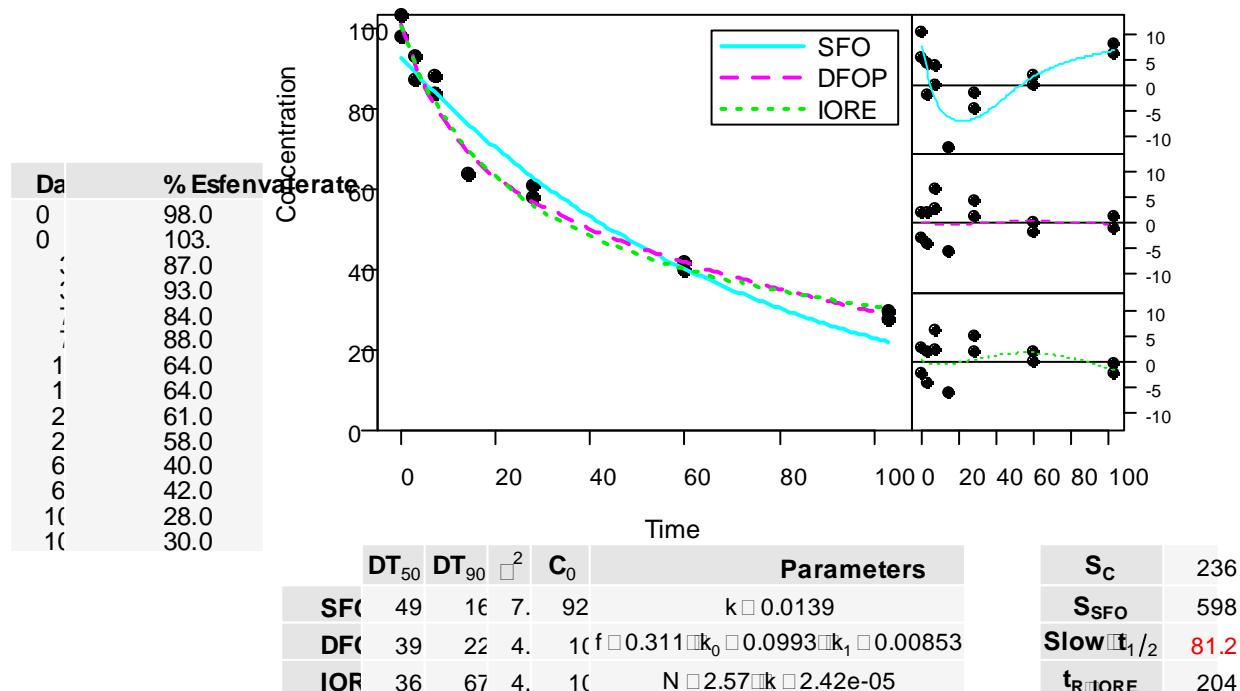
^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9j. Degradation Kinetics of Esfenvalerate in Three Aquatic Systems, Under Aerobic Conditions ^A

Aerobic Sediment 1

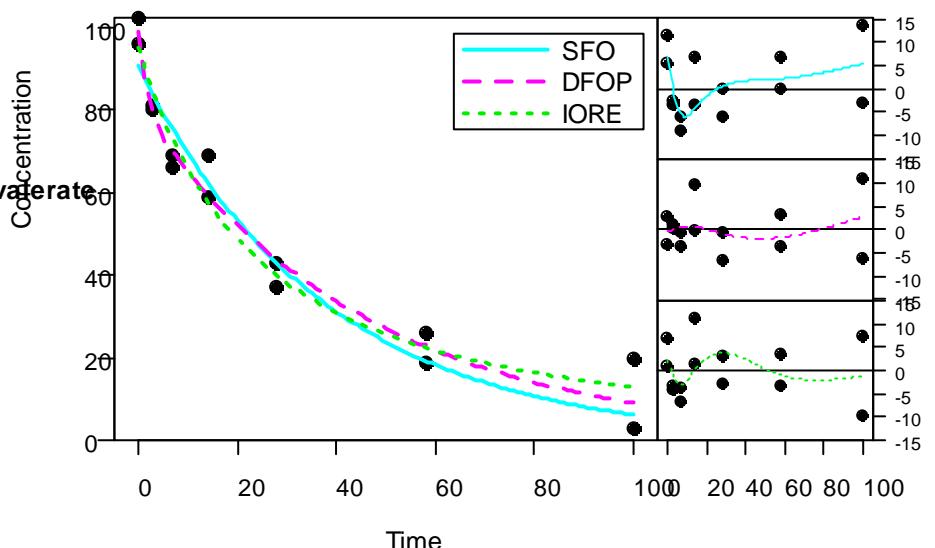


Aerobic Sediment 2



Aerobic Sediment 3

Da	% Esfenvater
0	96.0
0	102.
.	80.0
.	81.0
.	66.0
1	69.0
1	59.0
2	69.0
2	43.0
5	37.0
5	26.0
10	19.0
10	3.00
10	20.0



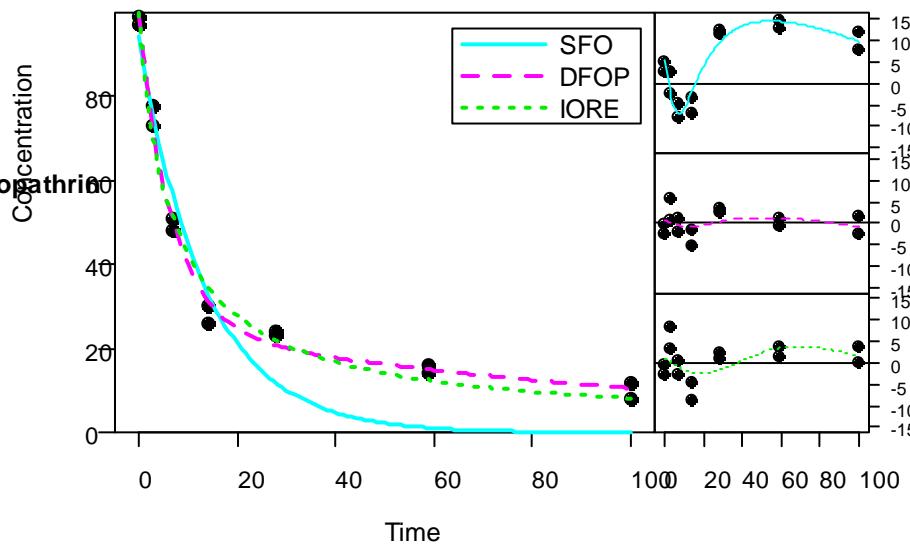
	DT_{50}	DT_{90}	\square^2	C_0	Parameters	S_C	554
SFO	20	86	7.	90	$k \square 0.0267$	S_{SFO}	636
DFP	22	91	4.	99	$f \square 0.185 \square k_0 \square 0.491 \square k_1 \square 0.0218$	Slow $t_{1/2}$	31.7
IOR	20	13	5.	95	$N \square 1.68 \square k \square 0.00192$	$t_{R\text{IOR}}$	39.6

^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9k. Degradation Kinetics of Fenpropathrin in Three Aquatic Systems, Under Aerobic Conditions ^A

Aerobic Sediment 1

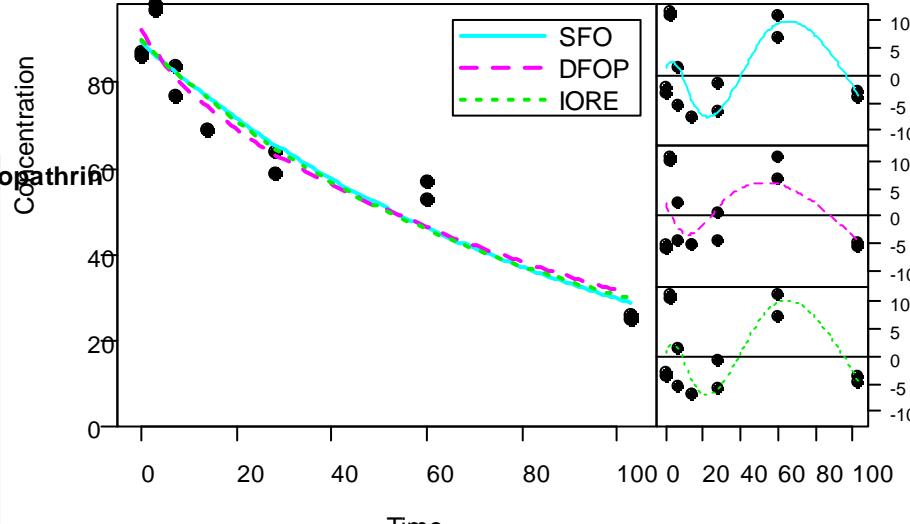
Da	% Fenpropathrin
0	99.0
0	97.0
.	73.0
.	78.0
.	48.0
.	51.0
1	30.0
1	26.0
2	24.0
2	23.0
5	16.0
5	14.0
10	8.00
10	12.0



	DT ₅₀	DT ₉₀	\square^2	C ₀	Parameters	S _C	278
SFO	9.1	30	1	94	k □ 0.0745	S _{SFO}	1.06e
DFP	7.0	10	4.	99 f □ 0.751 □ k ₀ □ 0.147 □ k ₁ □ 0.00856	Slow □ t _{1/2}	81	
IORE	7.2	78	7.	99	N □ 2.15 □ k □ 0.000741	t _{RIORE}	23.5

Aerobic Sediment 2

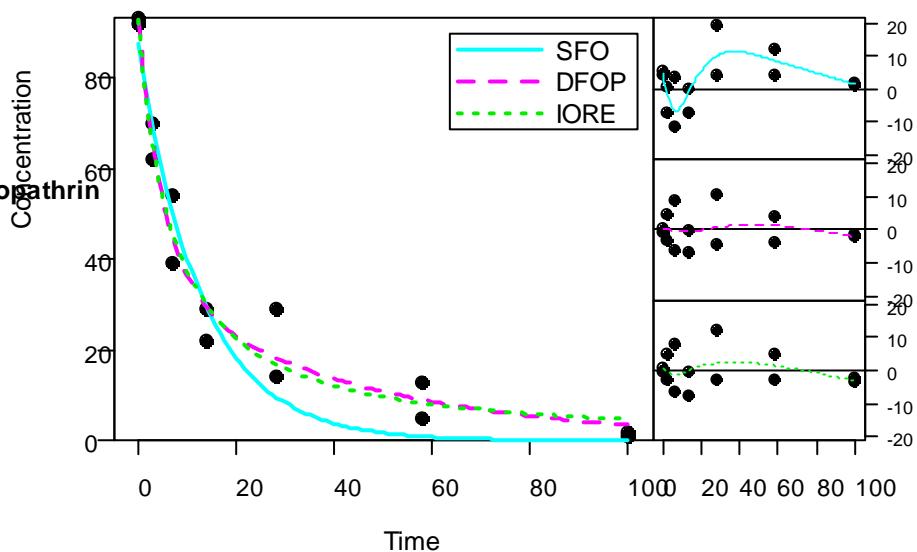
Da	% Fenpropathrin
0	86.0
0	87.0
.	97.0
.	98.0
.	84.0
1	77.0
1	69.0
1	69.0
2	59.0
2	64.0
6	53.0
6	57.0
10	26.0
10	25.0



	DT ₅₀	DT ₉₀	\square^2	C ₀	Parameters	S _C	789
SFO	63	21	7.	89	k □ 0.0109	S _{SFO}	644
DFP	60	23	8.	92 f □ 0.108 □ k ₀ □ 0.106 □ k ₁ □ 0.00952	Slow □ t _{1/2}	72.8	
IORE	6:	24	8.	89	N □ 1.2 □ k □ 0.00489	t _{RIORE}	73.4

Aerobic Sediment 3

Da	% Fenpropidin
0	93.0
0	92.0
.	70.0
.	62.0
.	54.0
1	39.0
1	29.0
2	22.0
2	29.0
5	14.0
5	13.0
10	5.00
10	2.00
10	1.00



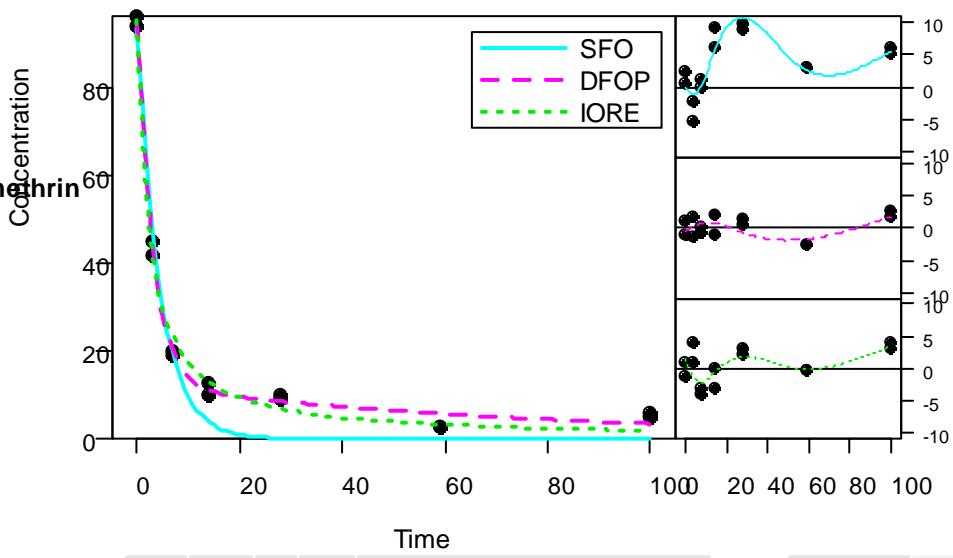
	DT ₅₀	DT ₉₀	R ²	C ₀	Parameters	S _c	
SFO	8.8	29	1	87	k = 0.0786	S _{SFO}	856
DFP	6.6	56	5.	92	f = 0.629, k ₀ = 0.186, k ₁ = 0.0232	Slow t _{1/2}	29.9
IORE	6.8	51	6.	92	N = 1.85, k = 0.00296	t _{RIORE}	15.6

^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9l. Degradation Kinetics of Permethrin in Three Aquatic Systems, Under Aerobic Conditions^A

Aerobic Sediment 1

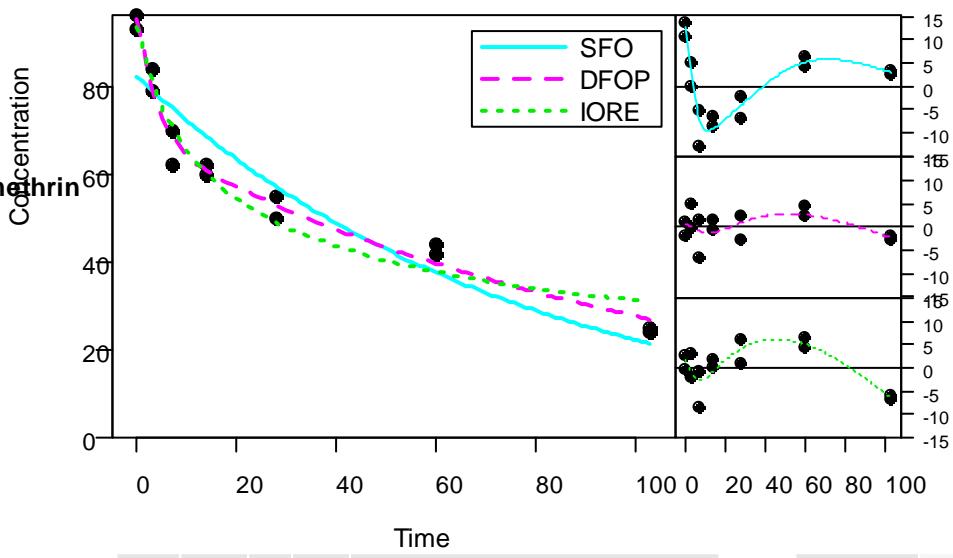
Da	% Permethrin
0	96.0
0	94.0
.	42.0
.	45.0
.	19.0
1	20.0
1	13.0
1	10.0
2	9.00
2	10.0
5	3.00
5	3.00
10	5.00
10	6.00



S _C	116
S _{SFO}	415
Slow □ t _{1/2}	55
t _R □ IORE	5.93

Aerobic Sediment 2

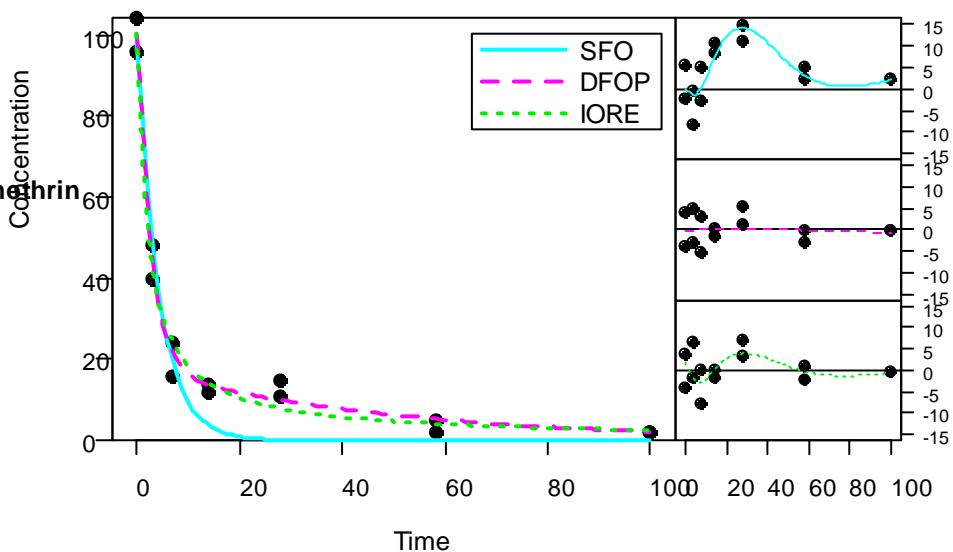
Da	% Permethrin
0	93.0
0	96.0
.	84.0
.	79.0
.	70.0
1	62.0
1	62.0
1	60.0
2	50.0
2	55.0
6	44.0
6	42.0
10	24.0
10	25.0



S _C	342
S _{SFO}	774
Slow □ t _{1/2}	77.4
t _R □ IORE	660

Aerobic Sediment 3

Da	% Permethrin
0	104.0
0	96.0
.	48.0
.	40.0
.	24.0
1	16.0
1	14.0
2	12.0
2	15.0
5	11.0
5	5.00
10	2.00
10	2.00

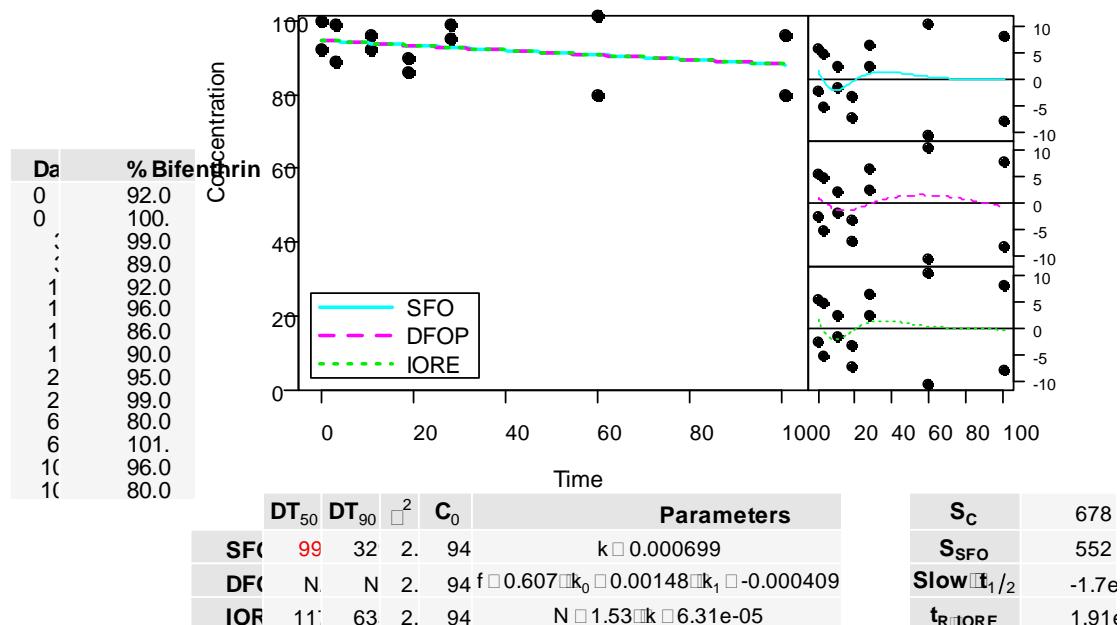


	DT ₅₀	DT ₉₀	R ²	C ₀	Parameters	S _C	258
SFO	2.9	9.7	1	98	k = 0.235	S_{SFO}	698
DFOP	2.4	27	ε	10 f = 0.822	k ₀ = 0.377 k ₁ = 0.0209	Slow t_{1/2}	33.2
IORE	2.1	21	8.	10	N = 2.08 k = 0.00328	t_{RIORE}	6.37

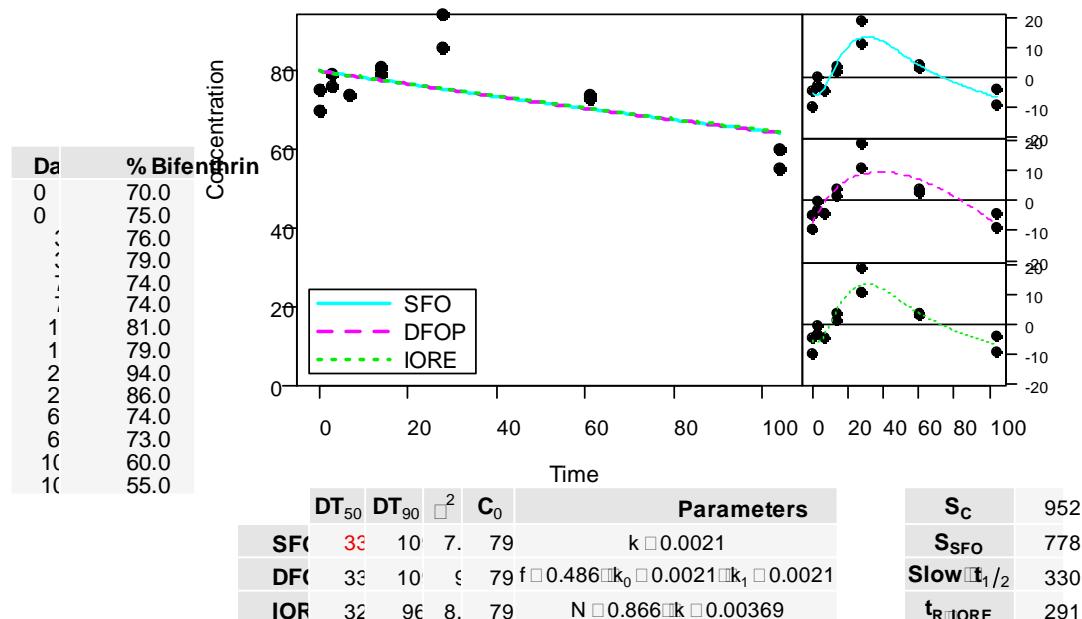
^a Data were obtained from Tables 12 and 13 (pp. 35-40) of study report. See Attachment 2 for raw data.

Table 9m. Degradation Kinetics of Bifenthrin (1) in Three Aquatic Systems, Under Anaerobic Conditions^A

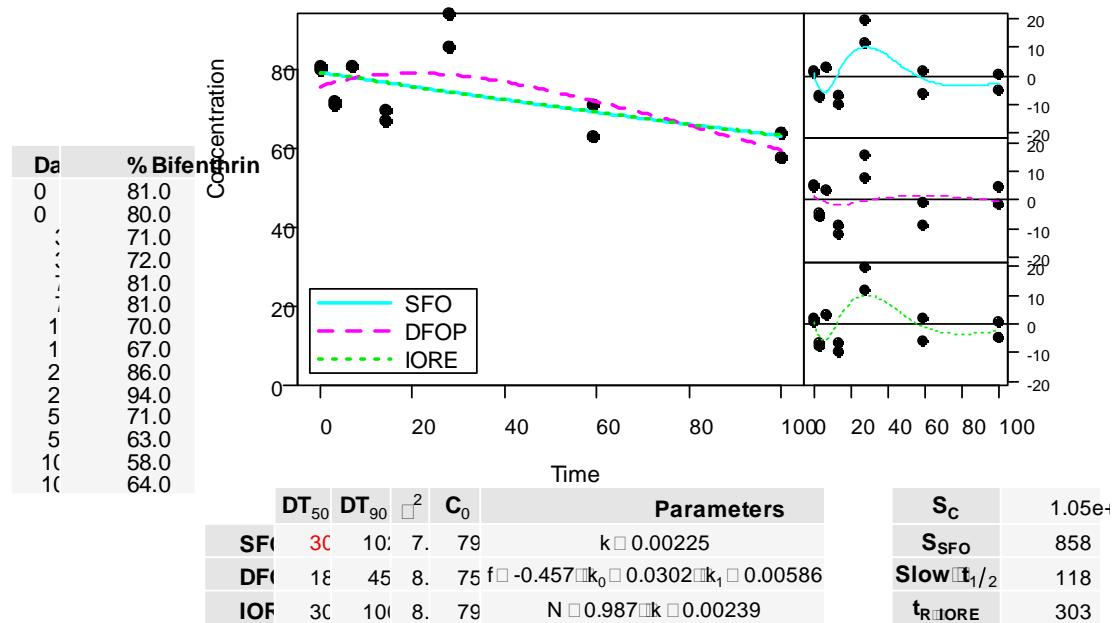
Anaerobic Sediment 1, Test Mixture 1



Anaerobic Sediment 2, Test Mixture 1



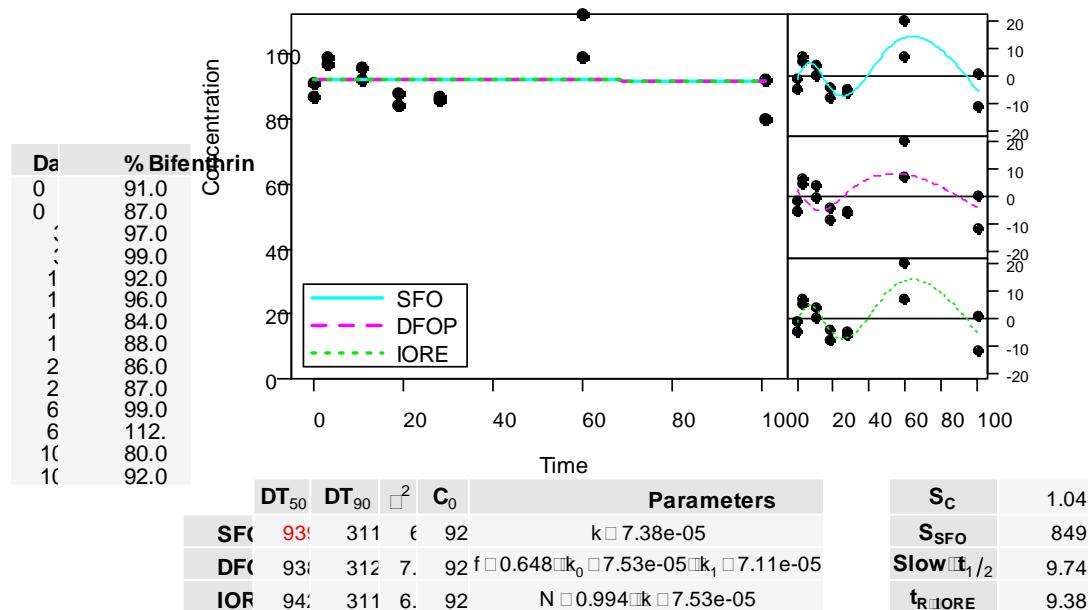
Anaerobic Sediment 3, Test Mixture 1



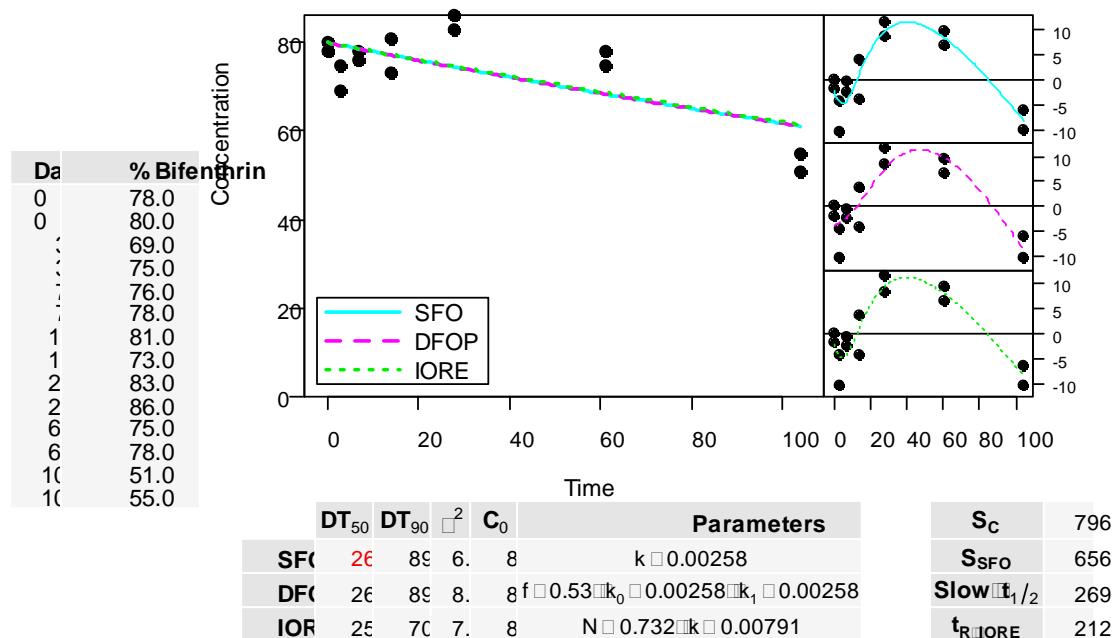
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9n. Degradation Kinetics of Bifenthrin (2) in Three Aquatic Systems, Under Anaerobic Conditions^A

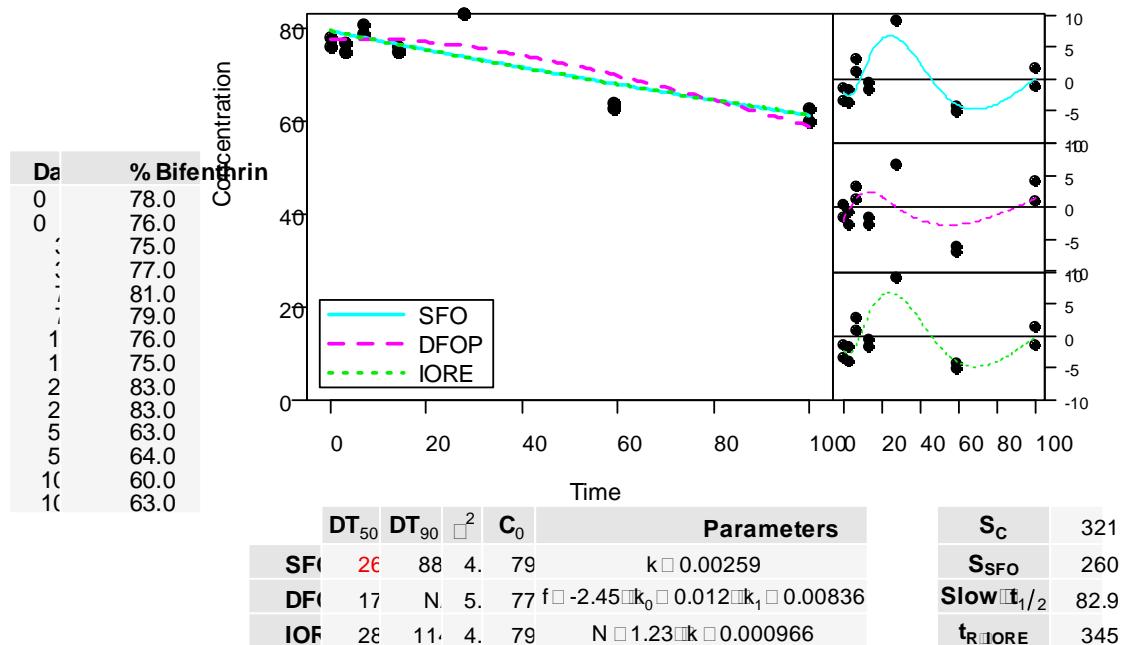
Anaerobic Sediment 1, Test Mixture 2



Anaerobic Sediment 2, Test Mixture 2



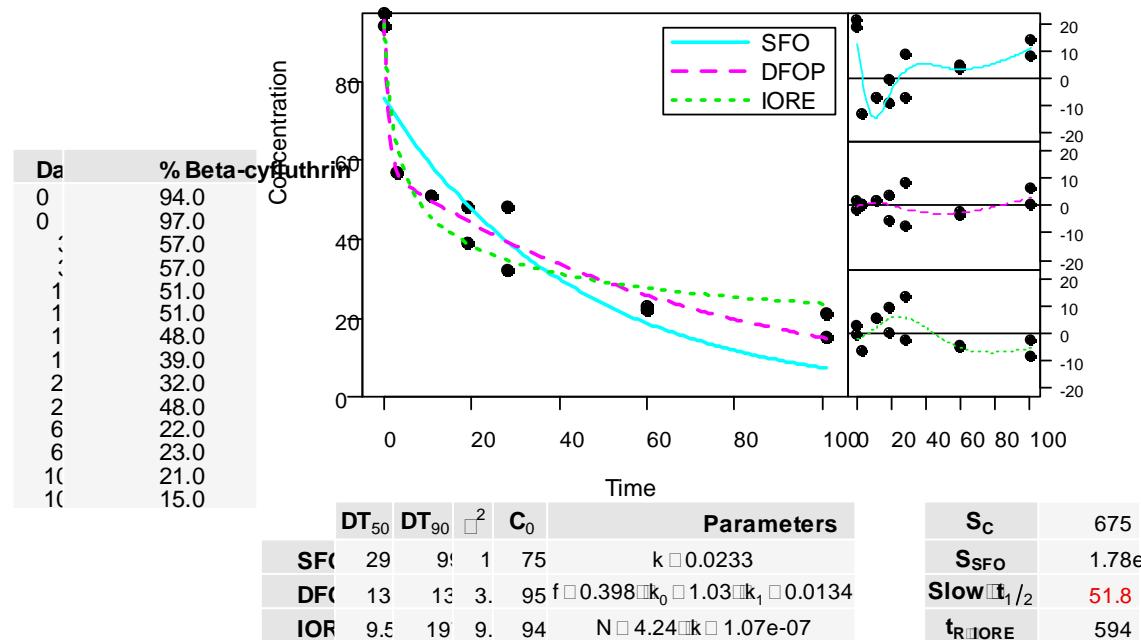
Anaerobic Sediment 3, Test Mixture 2



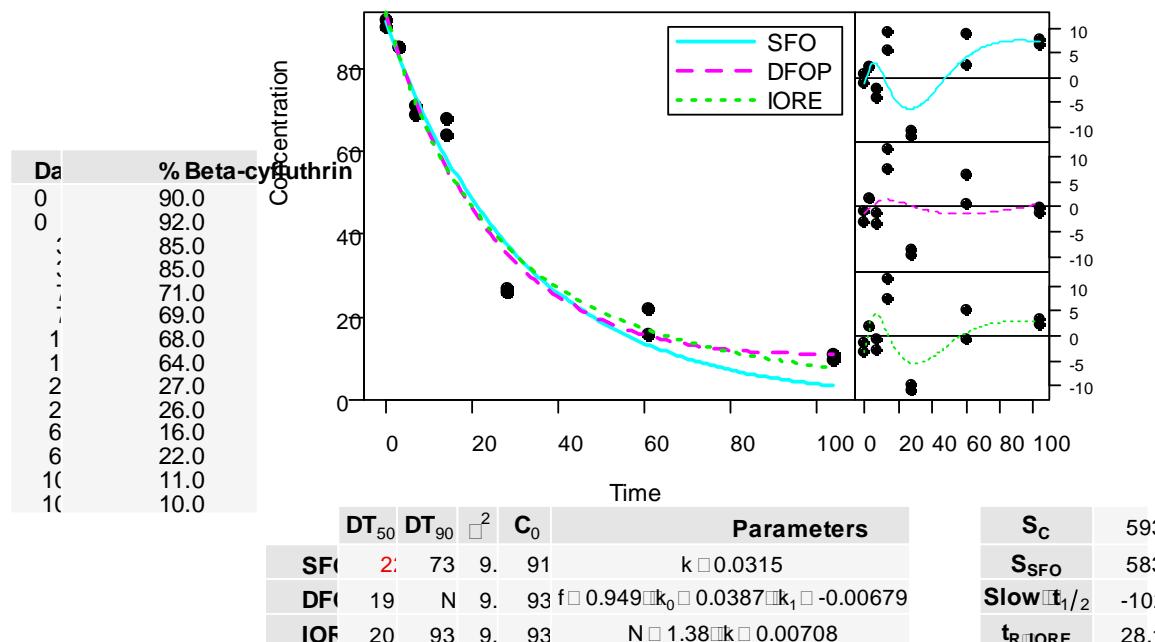
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9o. Degradation Kinetics of Beta-cyfluthrin in Three Aquatic Systems, Under Anaerobic Conditions^A

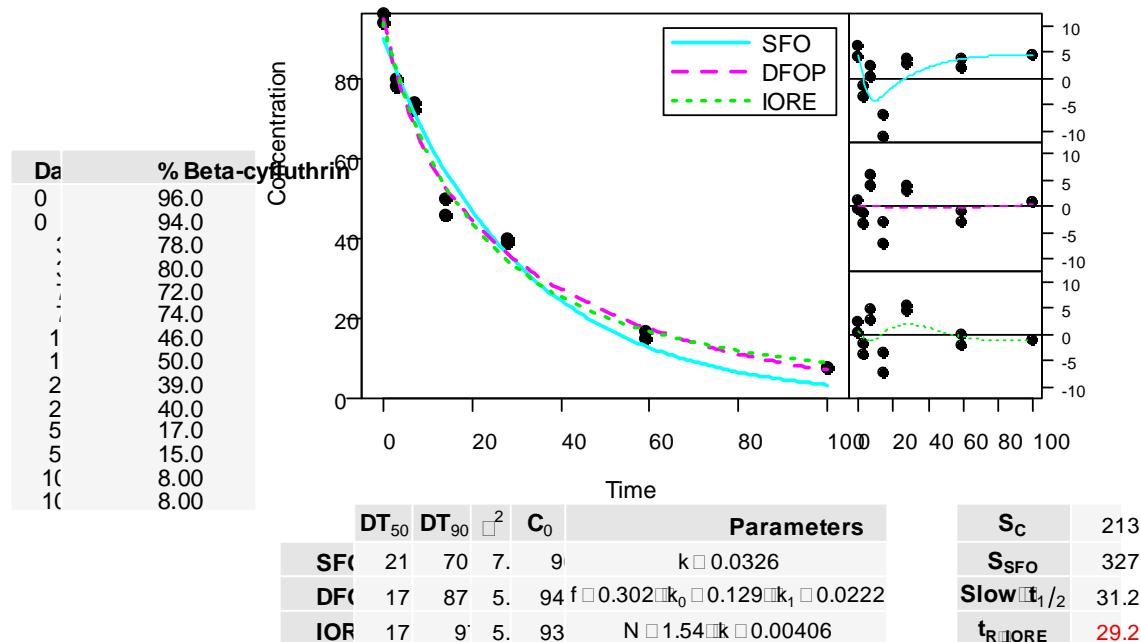
Anaerobic Sediment 1



Anaerobic Sediment 2



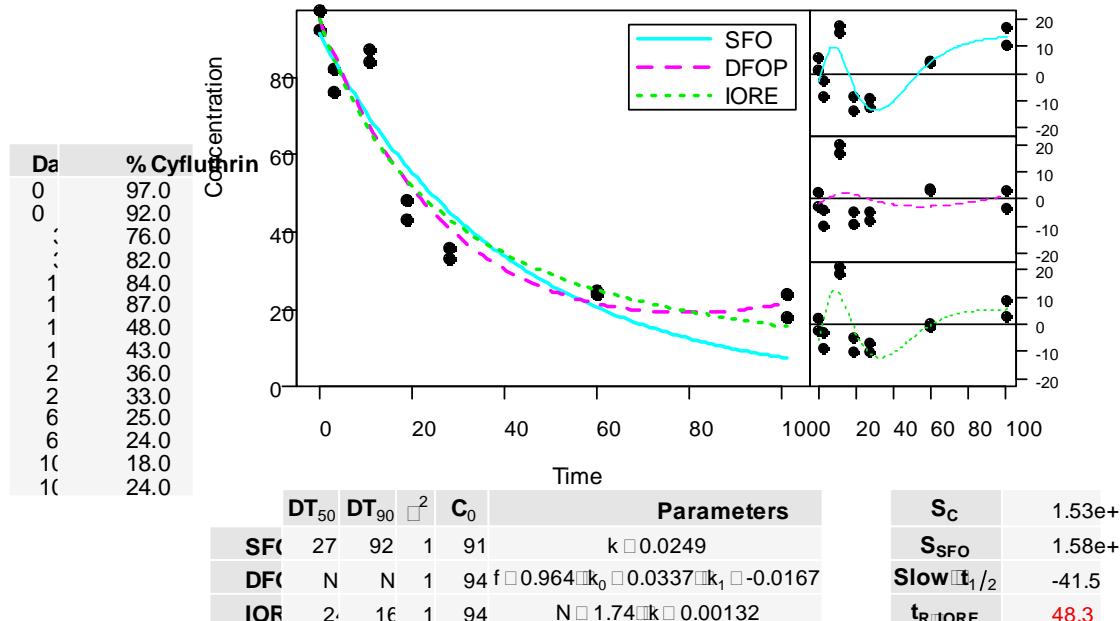
Anaerobic Sediment 3



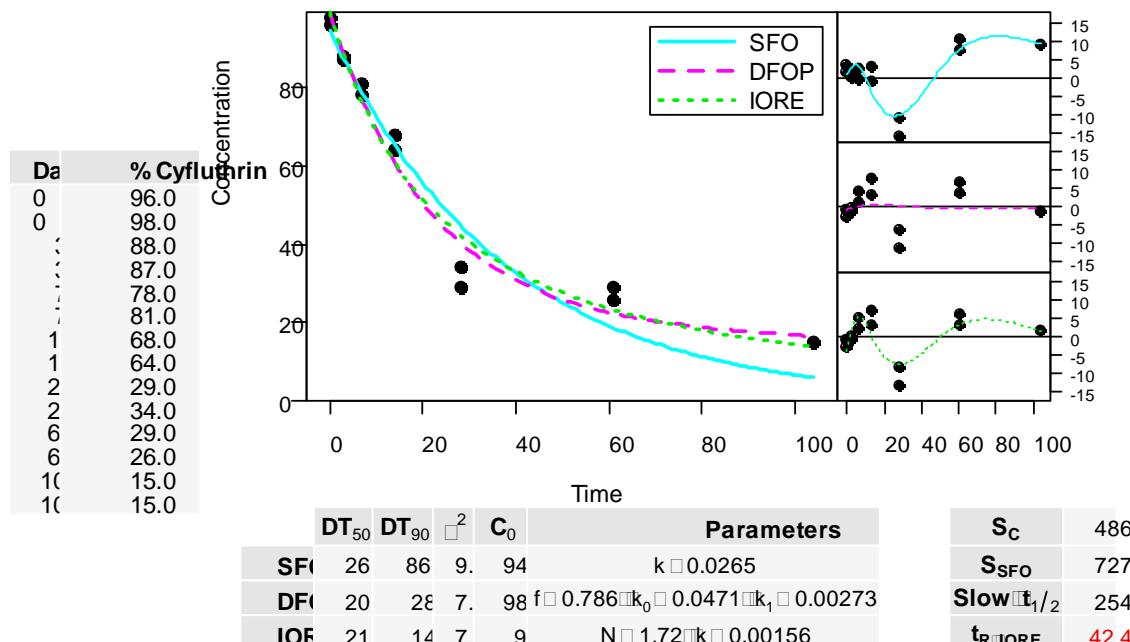
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9p. Degradation Kinetics of Cyfluthrin in Three Aquatic Systems, Under Anaerobic Conditions^A

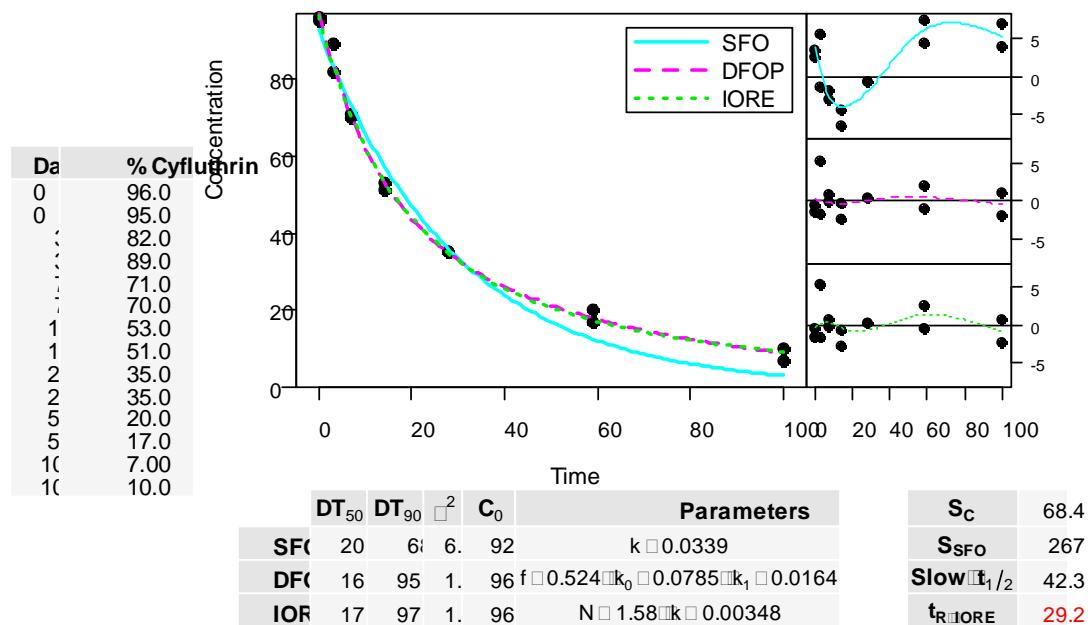
Anaerobic Sediment 1



Anaerobic Sediment 2



Anaerobic Sediment 3

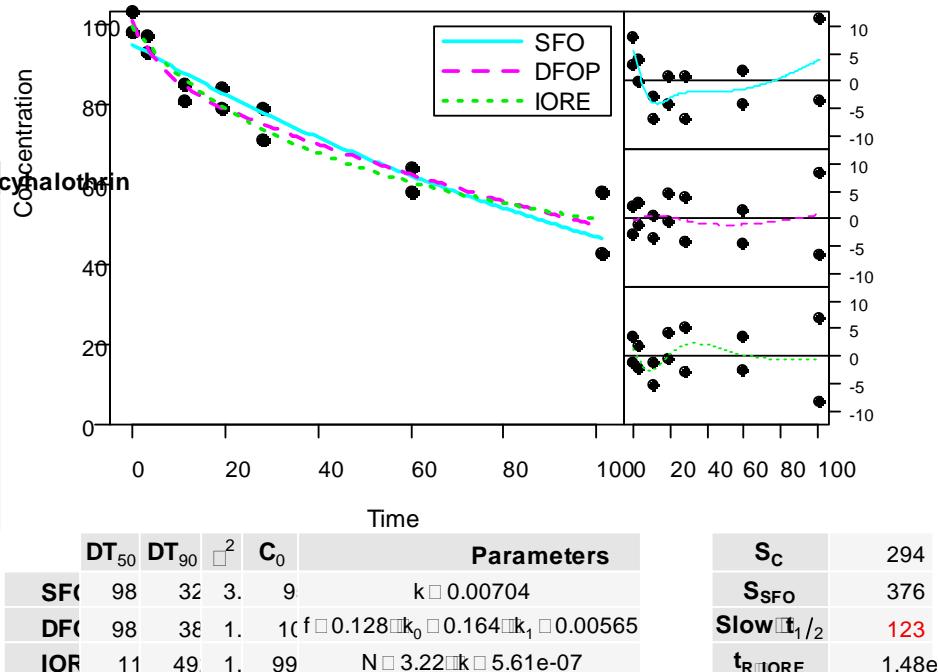


^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9q. Degradation Kinetics of *Gamma*-cyhalothrin in Three Aquatic Systems, Under Anaerobic Conditions^A

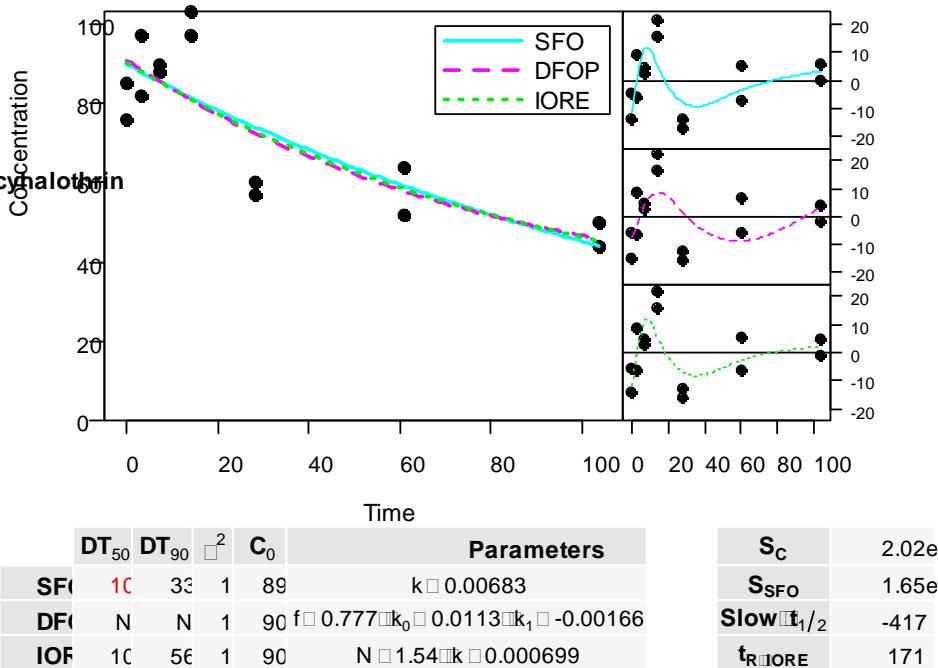
Anaerobic Sediment 1

Da	% Gamma-cyhalothrin
0	98.0
0	103.
.	97.0
.	93.0
1	81.0
1	85.0
1	84.0
1	79.0
2	71.0
2	79.0
6	58.0
6	64.0
10	58.0
10	43.0



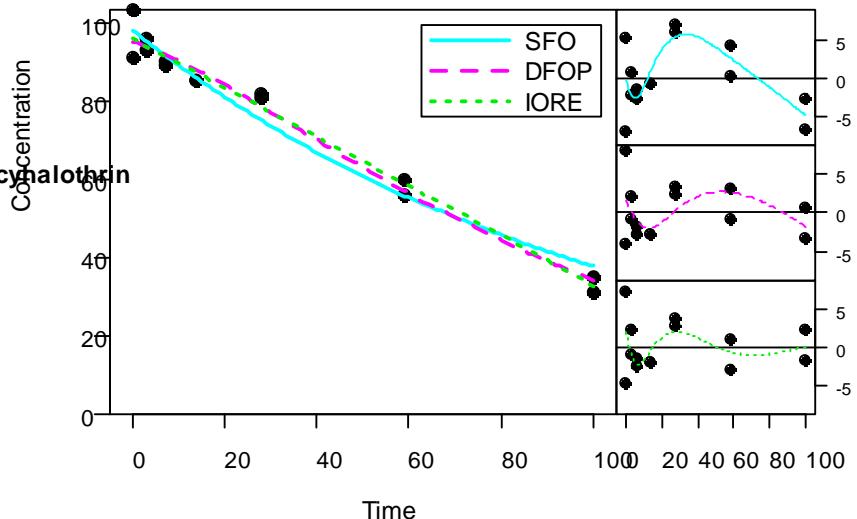
Anaerobic Sediment 2

Da	% Gamma-cyhalothrin
0	76.0
0	85.0
.	82.0
.	97.0
.	90.0
.	88.0
1	103.
1	97.0
2	60.0
2	57.0
6	52.0
6	64.0
10	50.0
10	44.0



Anaerobic Sediment 3

Da	% Gamma-cyhalothrin
0	103.
0	91.0
.	93.0
.	96.0
.	89.0
1	90.0
1	85.0
1	85.0
2	81.0
2	82.0
5	60.0
5	56.0
10	31.0
10	35.0



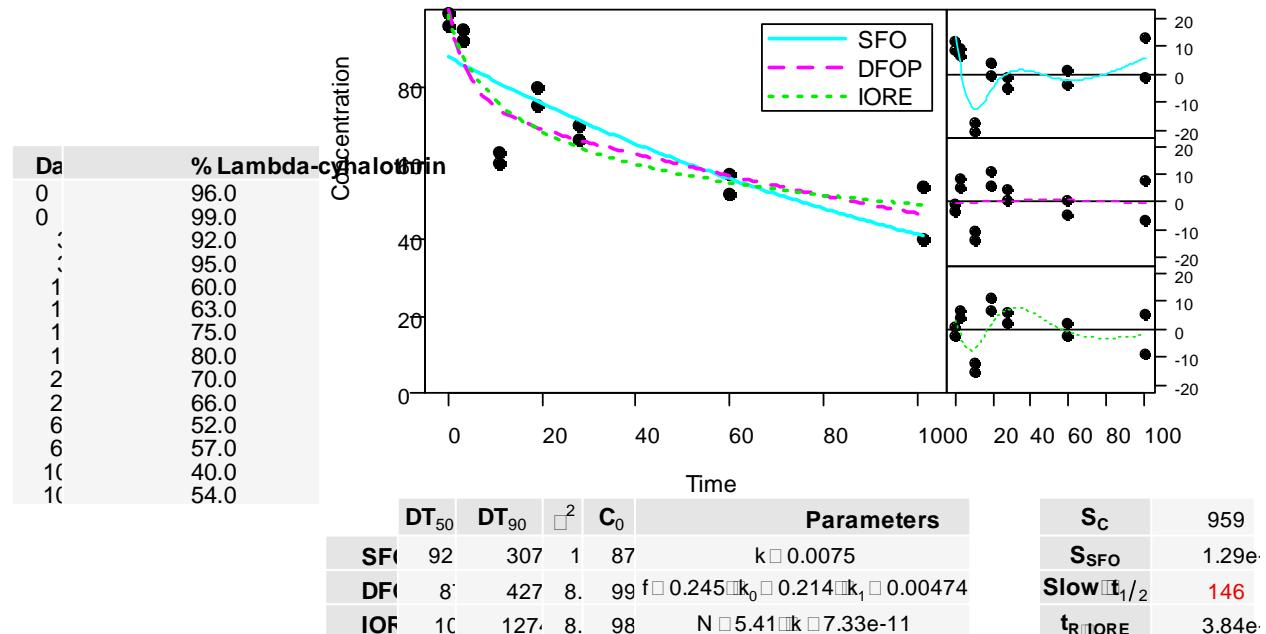
	DT ₅₀	DT ₉₀	C ₀	Parameters	S _C	166
SFO	72	24	3.	N ² 0.00952	S_{SFO}	246
DFOP	74	19	2.	f -0.692 k ₀ 0.0298 k ₁ 0.0145	Slow t_{1/2}	47.7
IORE	76	13	1.	N -0.0463 k 0.762	t_{RIORE}	40.7

For the last run, directly above, SFO results were used as representative. The tool PestDFV1.0 yields a representative half-life of 40.7 days. Inspection of the data shows that the observed DT₅₀ is 59-100 days and the calculated DT₅₀ is 76.6 days using the tool-selected IORE model. Since the representative half-life does not appear to be conservative and the N value is less than 1 (one), a half-life from the SFO model was selected

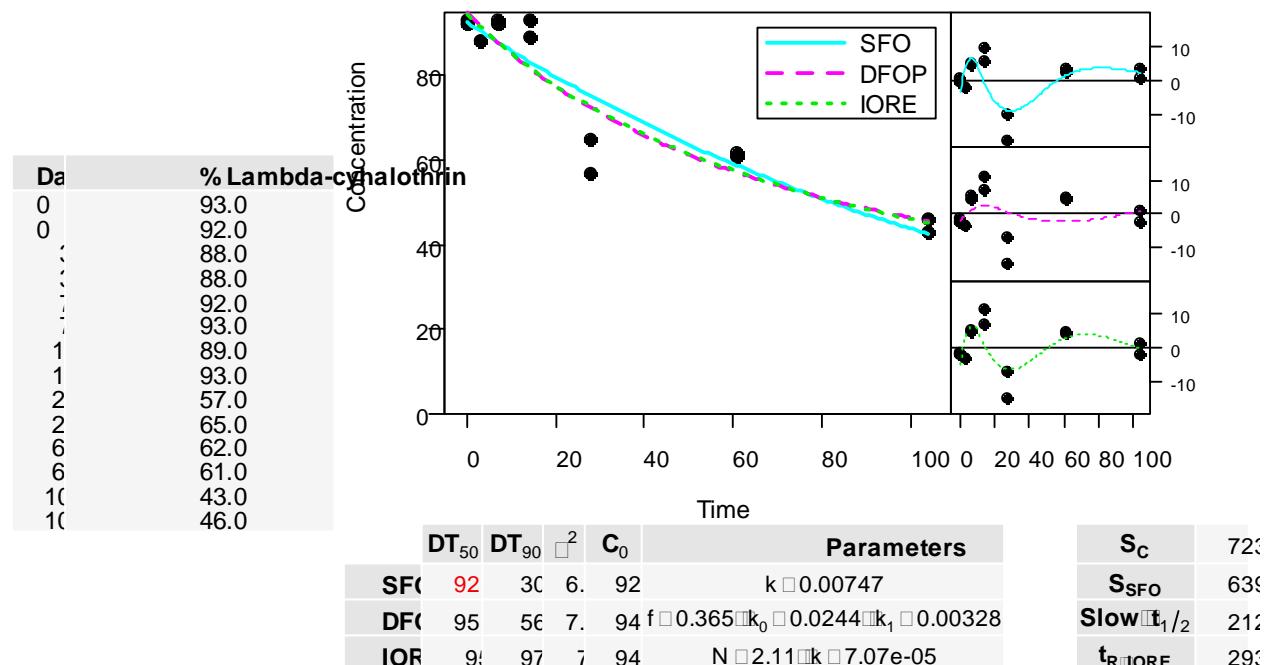
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9r. Degradation Kinetics of *Lambda*-cyhalothrin in Three Aquatic Systems, Under Anaerobic Conditions^A

Anaerobic Sediment 1

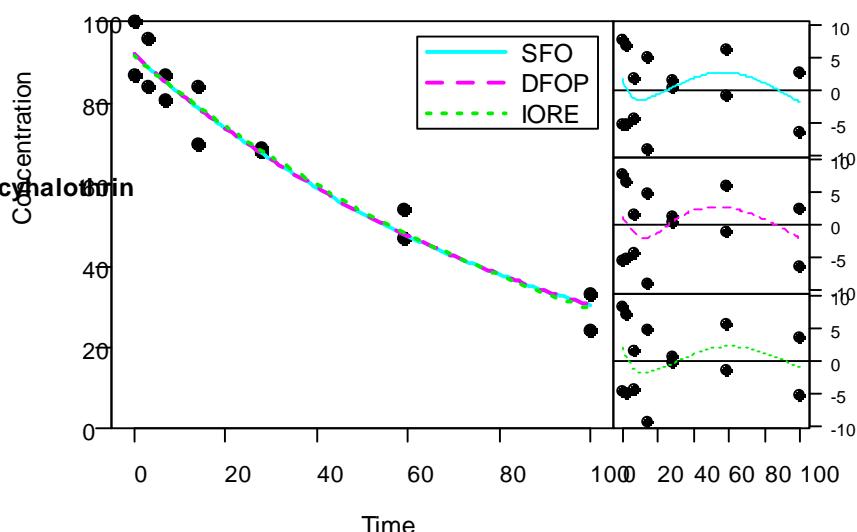


Anaerobic Sediment 2



Anaerobic Sediment 3

Da	% Lambda-cyanotinin
0	100.
0	87.0
.	84.0
.	96.0
.	87.0
.	81.0
1	84.0
1	70.0
2	68.0
2	69.0
5	47.0
5	54.0
10	24.0
10	33.0



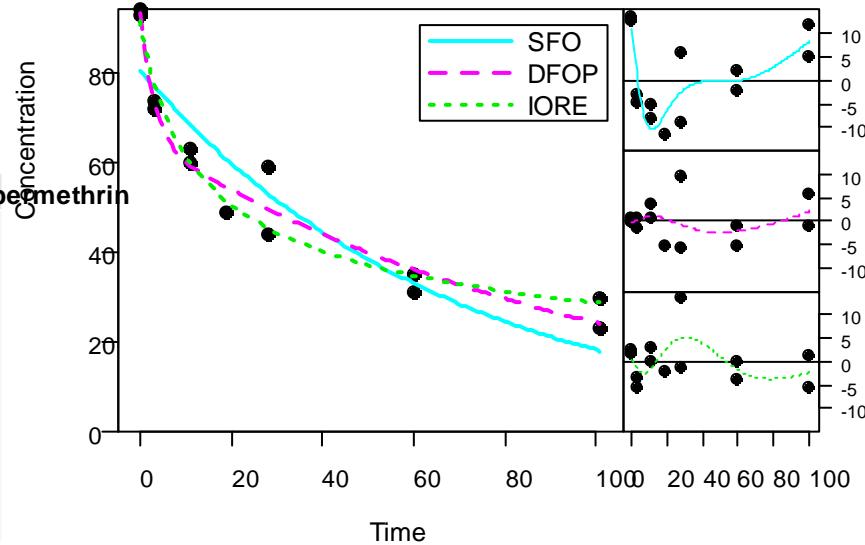
	DT_{50}	DT_{90}	\square^2	C_0	Parameters	S_C	45
SFO	62	20	1.	92	$k \square 0.0111$	S_{SFO}	370
DFOP	62	20	2.	92	$f \square 0.326 \square k_0 \square 0.0111 \square k_1 \square 0.0111$	Slow $t_{1/2}$	62.4
IORE	63	18	1.	91	$N \square 0.806 \square k \square 0.0245$	t_{RIORE}	54.0

^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9s. Degradation Kinetics of Zeta-cypermethrin in Three Aquatic Systems, Under Anaerobic Conditions^A

Anaerobic Sediment 1

Da	% Zeta-cypermethrin
0	93.0
0	94.0
.	74.0
.	72.0
1	60.0
1	63.0
1	49.0
2	44.0
2	59.0
6	31.0
6	35.0
10	30.0
10	23.0

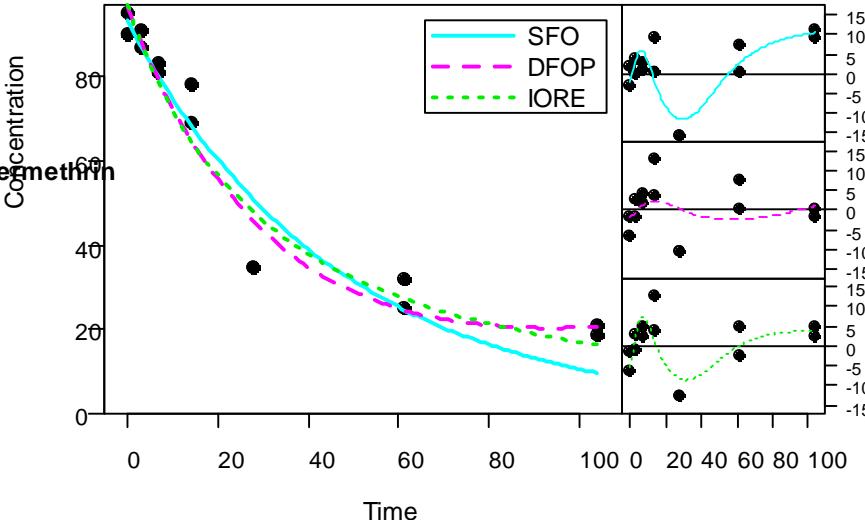


	DT ₅₀	DT ₉₀	\square^2	C ₀	Parameters	S _C
SFO	46	15	1	80	k \square 0.0148	37
DFOP	34	19	4.	93 f \square 0.3 \square k ₀ \square 0.344 \square k ₁ \square 0.00985		90
IORE	27	18	5.	91	N \square 3.52 \square k \square 7.95e-07	Slow \square t _{1/2} \square 70.

	t _{RIORE}
	57

Anaerobic Sediment 2

Da	% Zeta-cypermethrin
0	90.0
0	95.0
.	87.0
.	91.0
.	83.0
1	81.0
1	78.0
1	69.0
2	35.0
2	35.0
6	25.0
6	32.0
10	21.0
10	19.0

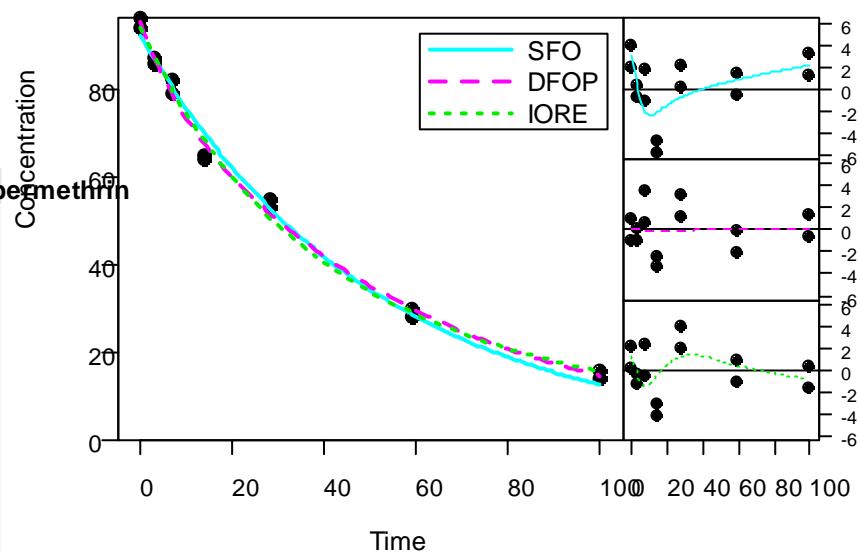


	DT ₅₀	DT ₉₀	\square^2	C ₀	Parameters	S _C
SFO	3.	10	1	9	k \square 0.0217	78
DFOP	N	N	8.	96 f \square 0.932 \square k ₀ \square 0.0317 \square k ₁ \square -0.00931		88
IORE	27	16	9	96	N \square 1.65 \square k \square 0.00164	Slow \square t _{1/2} \square -74

	t _{RIORE}
	50.

Anaerobic Sediment 3

Da	% Zeta-cypermethrin
0	96.0
0	94.0
.	86.0
.	87.0
.	79.0
1	82.0
1	65.0
2	64.0
2	53.0
5	55.0
5	30.0
10	28.0
10	14.0
10	16.0

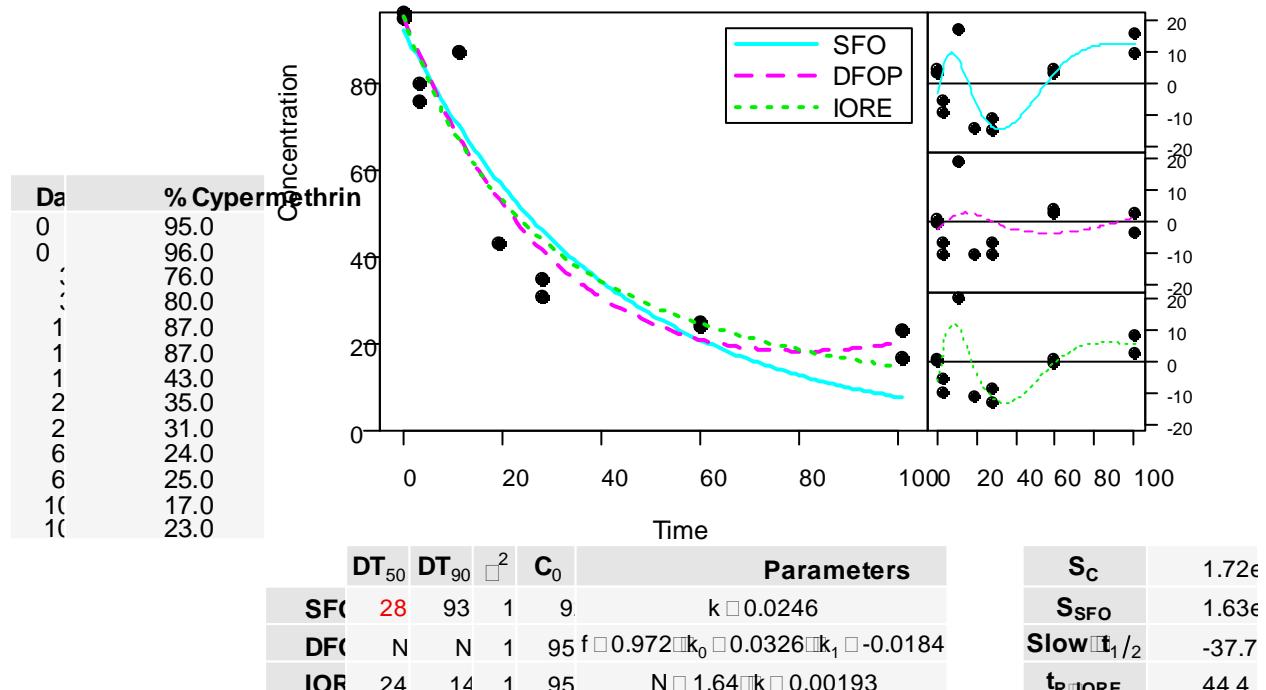


	DT_{50}	DT_{90}	\square^2	C_0	Parameters	S_C	80.
SFO	38	11	3.	92	$k \square 0.0198$	S_{SFO}	10
DFOP	32	12	2.	95	$f \square 0.113 \square k_0 \square 0.147 \square k_1 \square 0.0175$	Slow $t_{1/2}$	39.
IORE	32	14	2.	93	$N \square 1.32 \square k \square 0.00571$	t_{RIORE}	42.

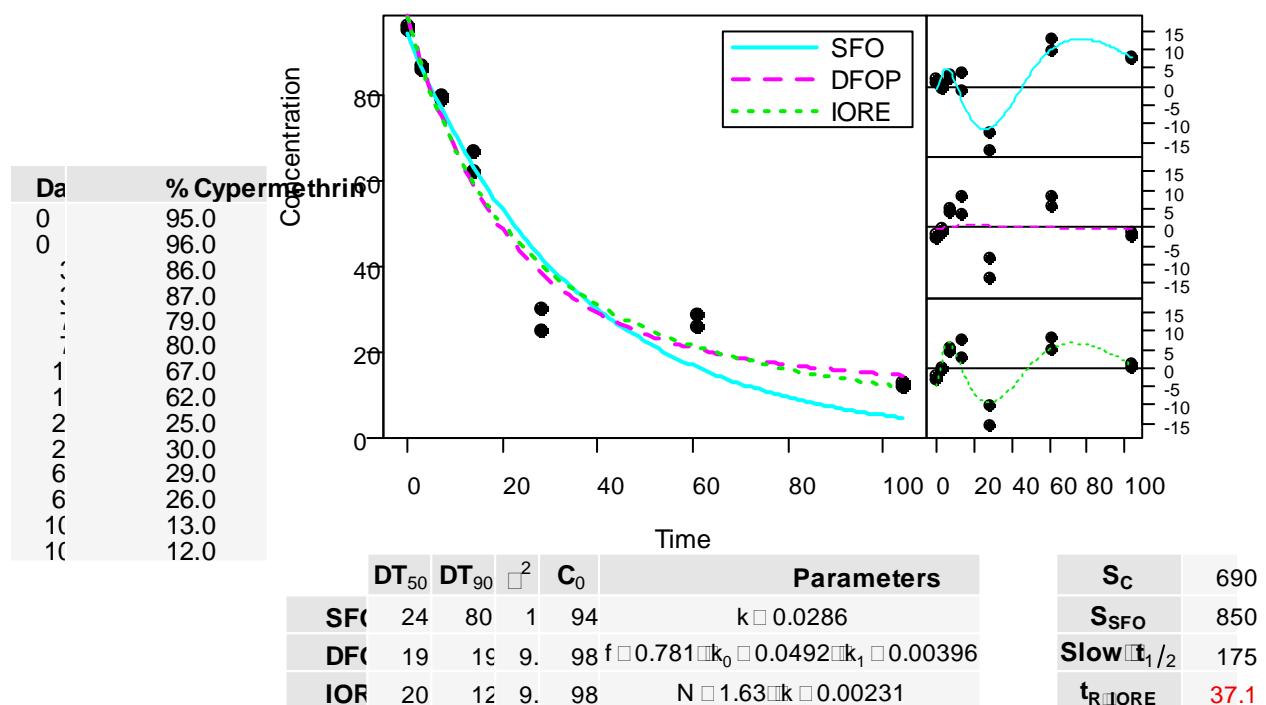
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9t. Degradation Kinetics of Cypermethrin in Three Aquatic Systems, Under Anaerobic Conditions^A

Anaerobic Sediment 1

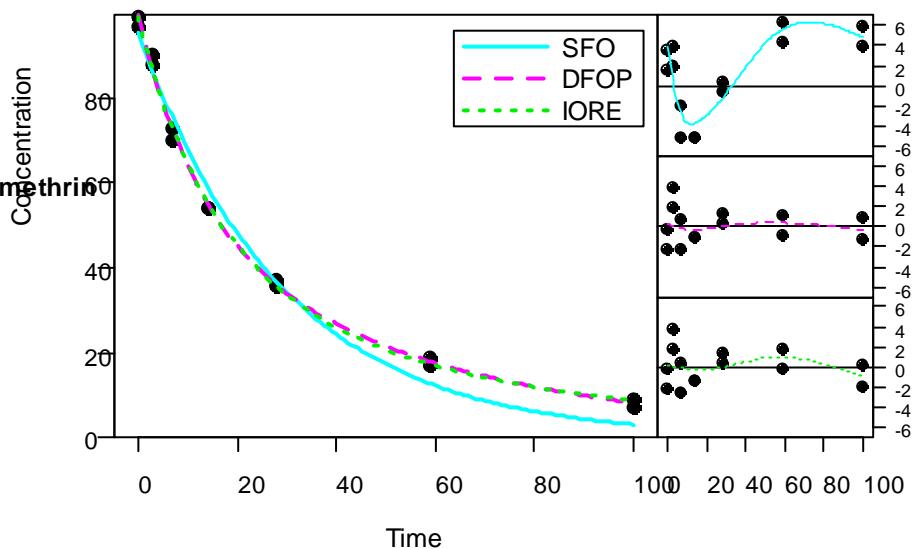


Anaerobic Sediment 2



Anaerobic Sediment 3

Da	% Cypermethrin
0	99.0
0	97.0
.	88.0
.	90.0
.	73.0
1	70.0
1	54.0
2	54.0
2	36.0
2	37.0
5	19.0
5	17.0
10	7.00
10	9.00

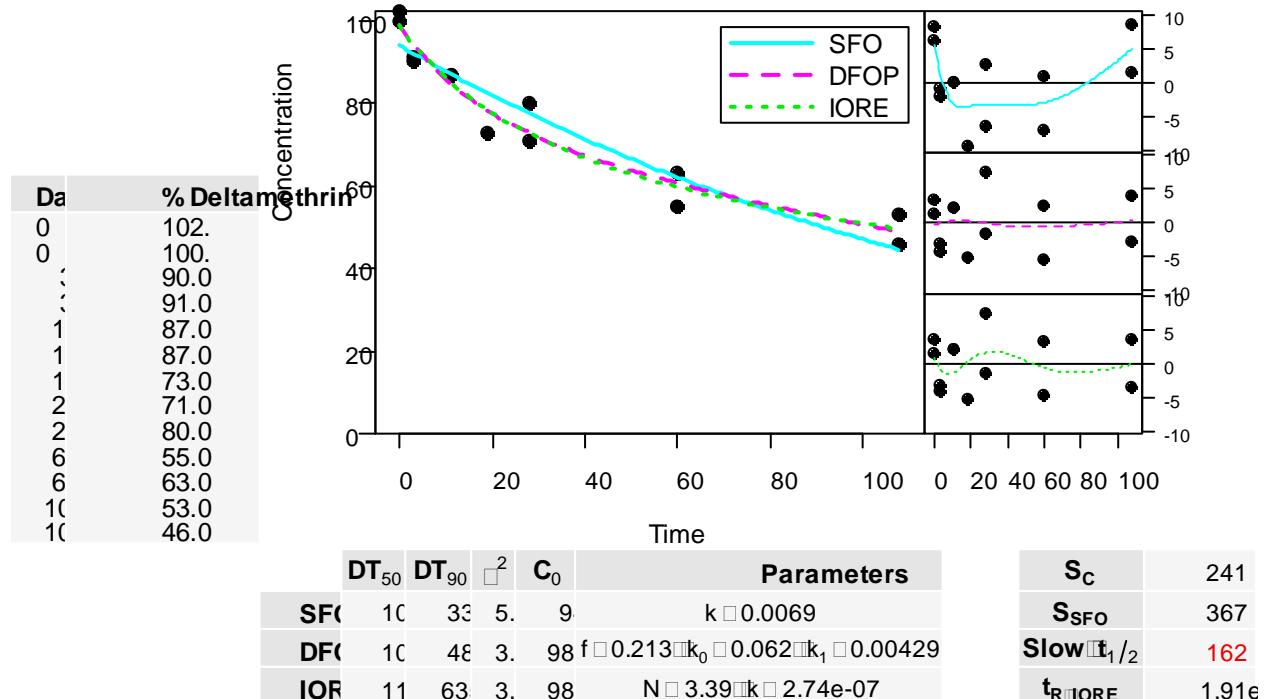


	DT ₅₀	DT ₉₀	\square^2	C ₀	Parameters	S _C	52.2
SFO	20	67	5.	95	$k \square 0.0342$	S_{SFO}	225
DFP	1	89	2.	99	$f \square 0.475 \square k_0 \square 0.0825 \square k_1 \square 0.0185$	Slow t_{1/2}	37.5
IOF	17	92	2.	99	$N \square 1.53 \square k \square 0.00433$	t_{RIORE}	27.8

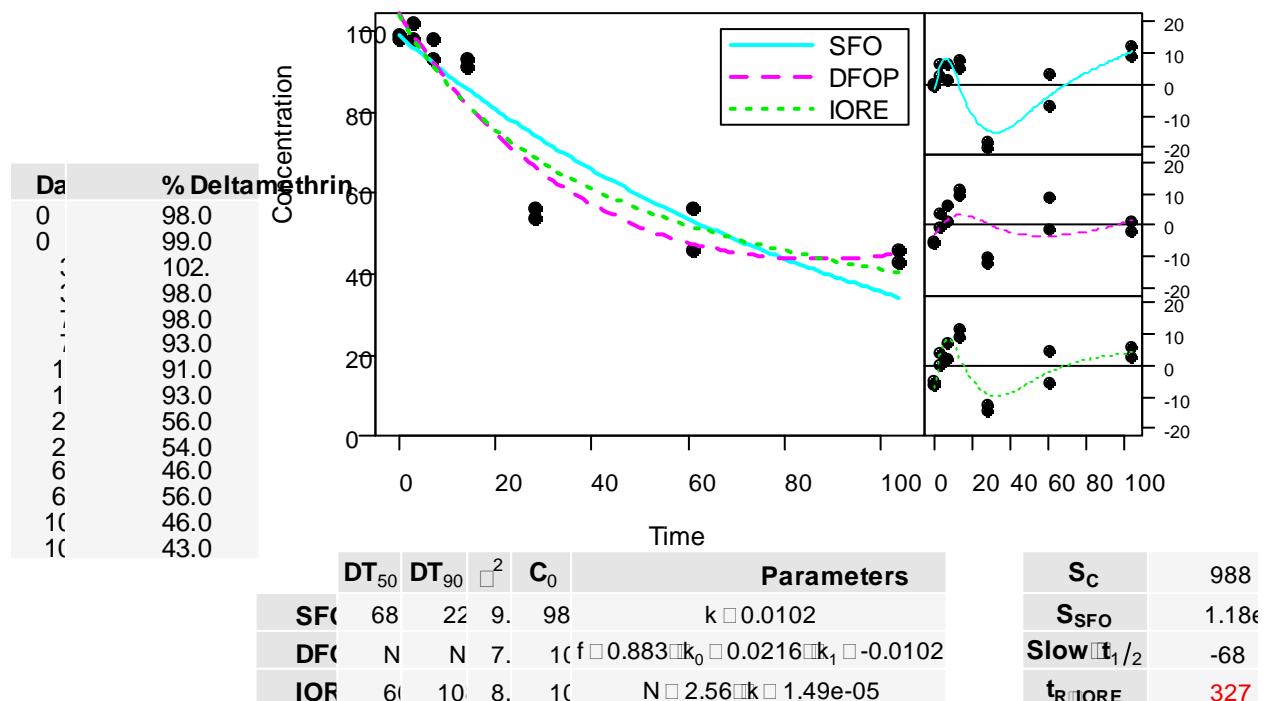
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9u. Degradation Kinetics of Deltamethrin in Three Aquatic Systems, Under Anaerobic Conditions^A

Anaerobic Sediment 1

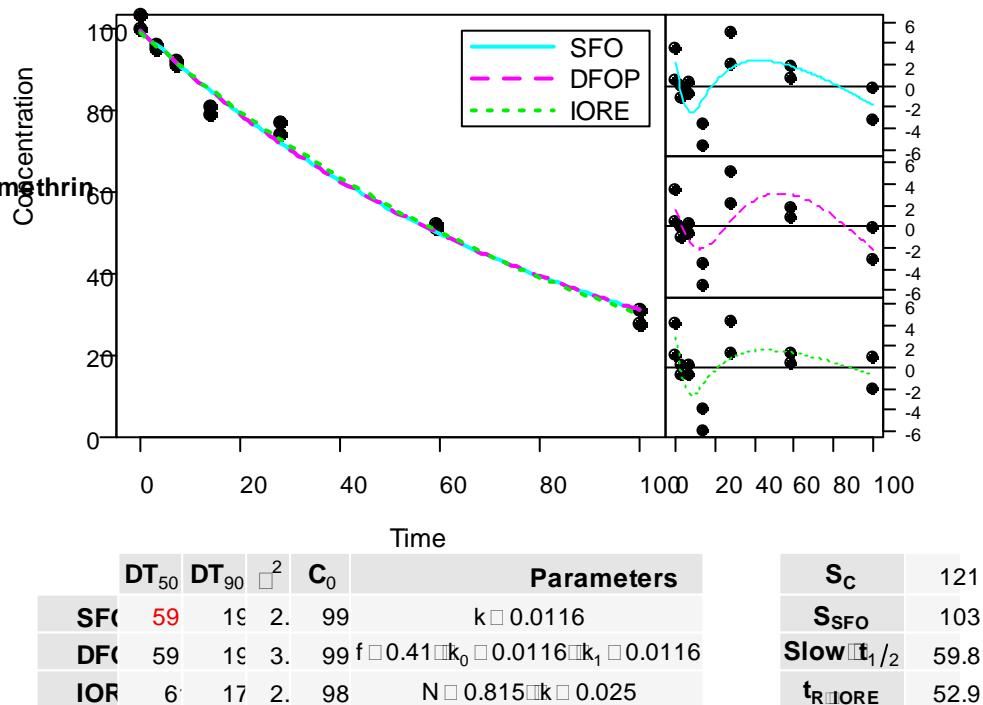


Anaerobic Sediment 2



Anaerobic Sediment 3

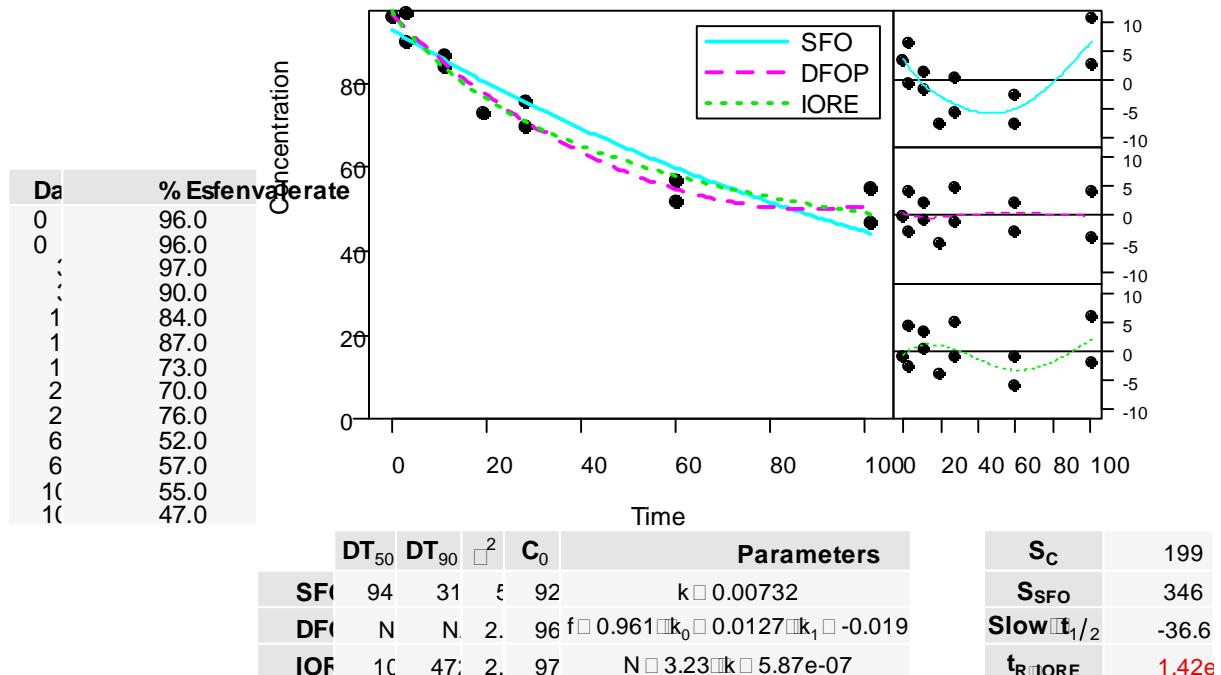
Da	% Deltamethrin
0	103.
0	100.
.	96.0
.	95.0
.	91.0
1	92.0
1	79.0
1	81.0
2	77.0
2	74.0
5	52.0
5	51.0
10	28.0
10	31.0



^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

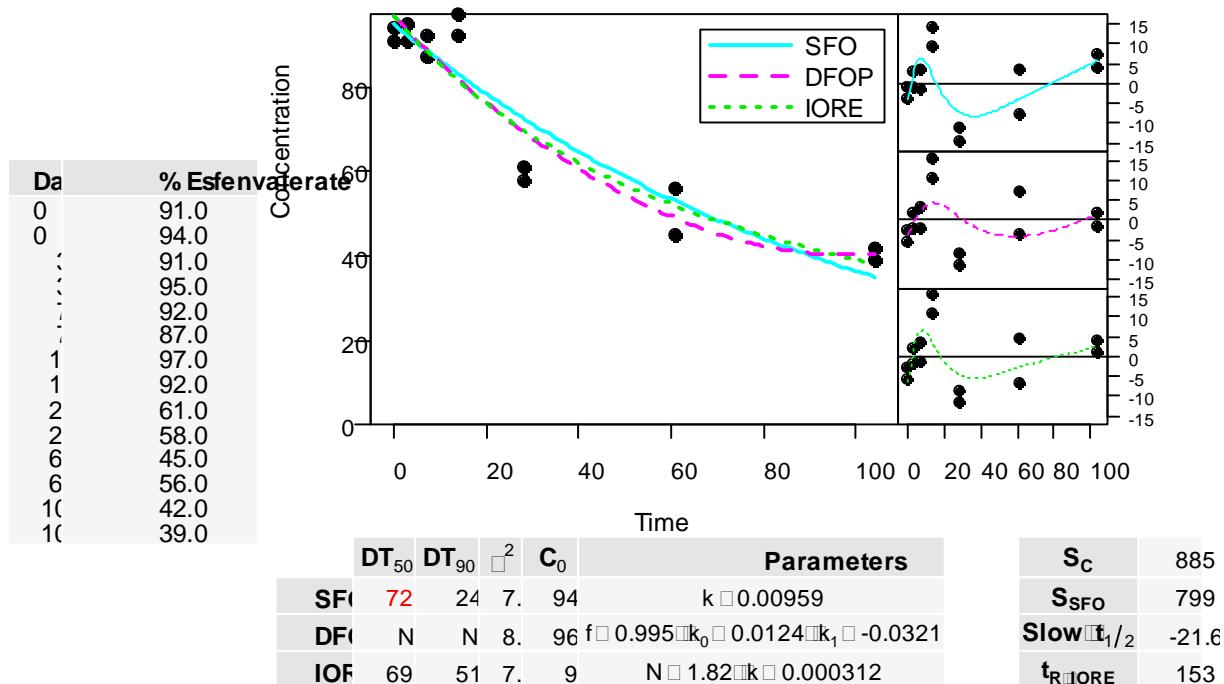
Table 9v. Degradation Kinetics of Esfenvalerate in Three Aquatic Systems, Under Anaerobic Conditions^A

Anaerobic Sediment 1



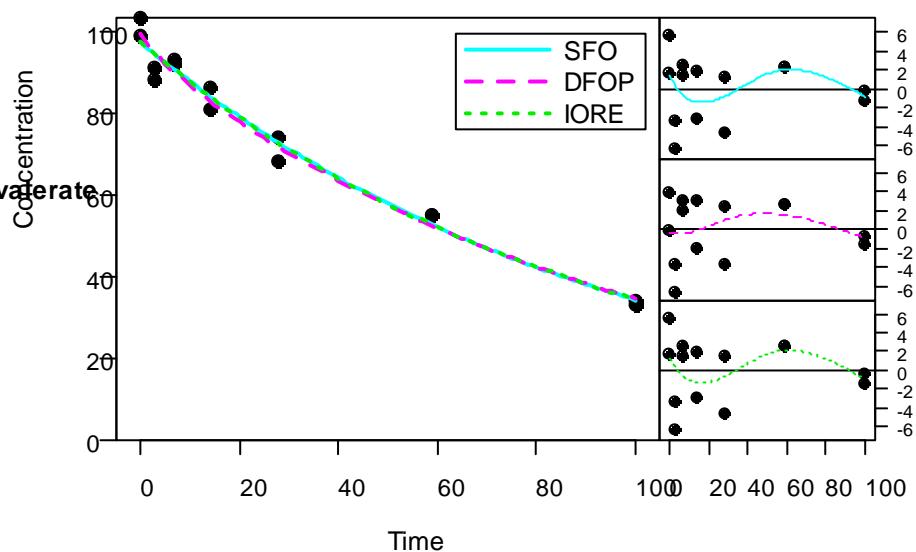
The above data was run in the Excel Solver and it was found that the SFO was a better fit for the data. The slow t_{1/2} was negative.

Anaerobic Sediment 2



Anaerobic Sediment 3

Da	% Esfenvaterate
0	103.
0	99.0
.	88.0
.	91.0
.	92.0
1	93.0
1	86.0
1	81.0
2	68.0
2	74.0
5	55.0
5	55.0
10	33.0
10	34.0

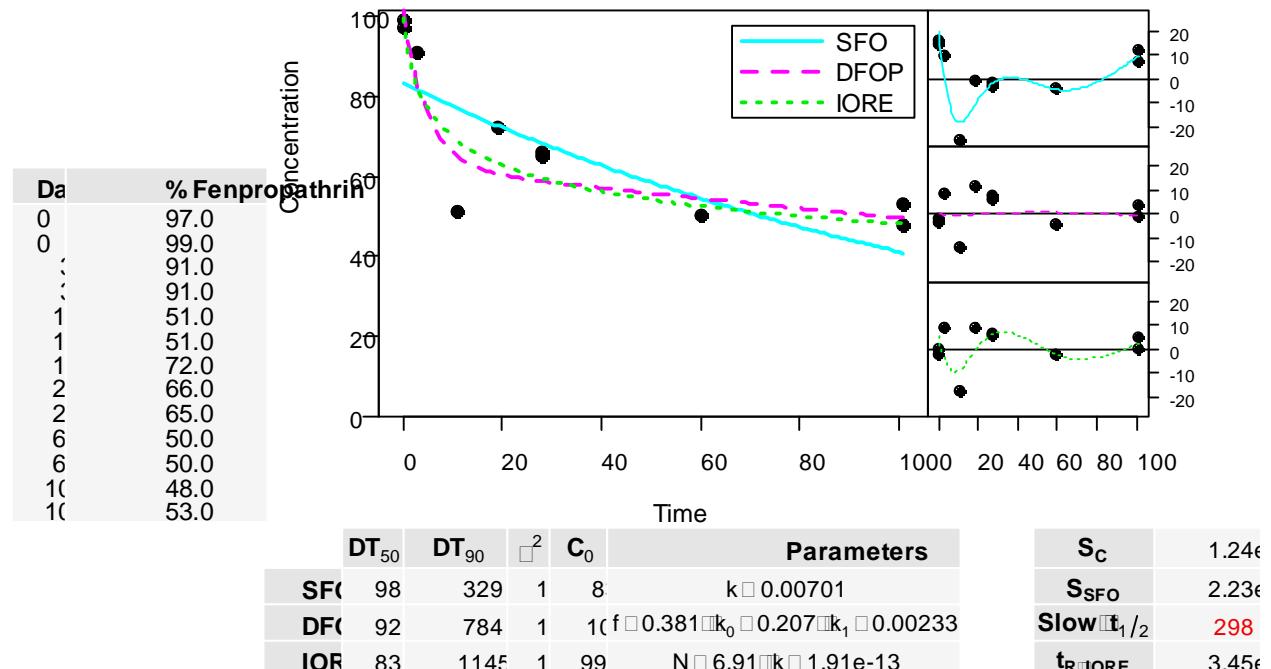


	DT ₅₀	DT ₉₀	\square^2	C ₀	Parameters	S _C	178
SFO	66	22	2.	97	$k \square 0.0104$	S_{SFO}	145
DFP	64	22	3.	99	$f \square 0.0429 \square k_0 \square 0.155 \square k_1 \square 0.0101$	Slow t_{1/2}	68.8
IOF	66	22	3.	97	$N \square 1.04 \square k \square 0.00894$	t_{RIORE}	68.4

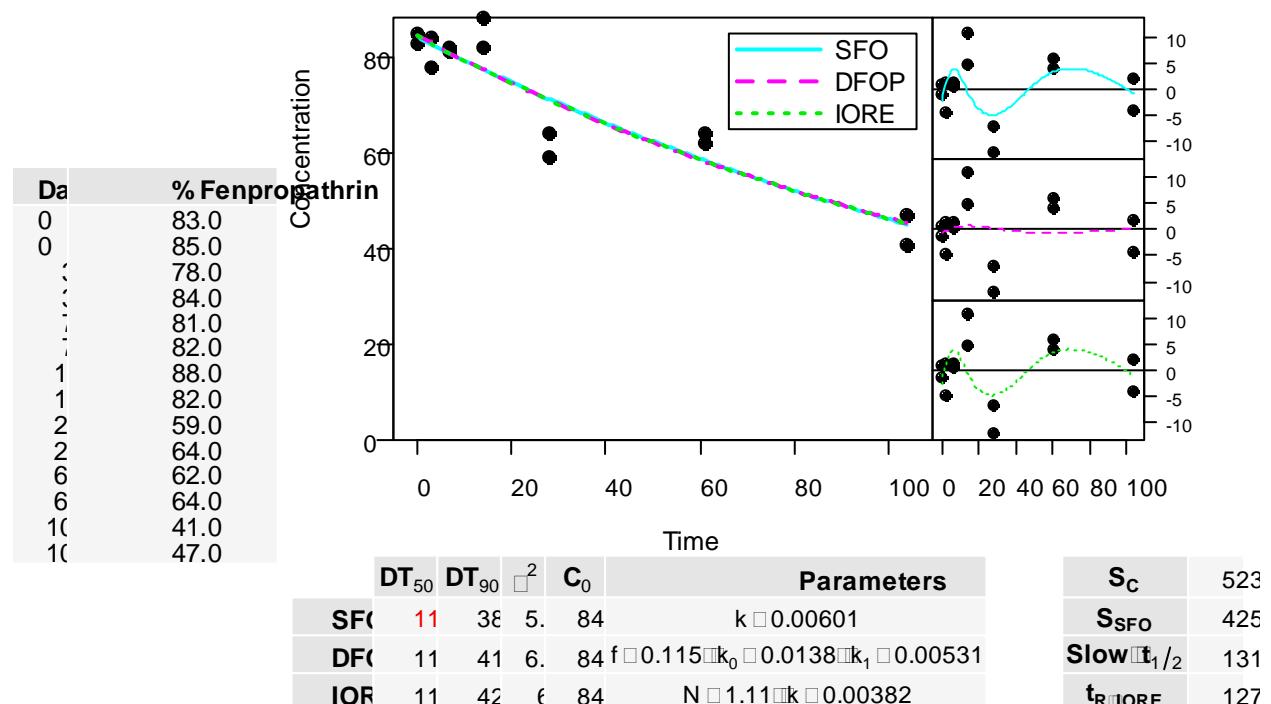
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9w. Degradation Kinetics of Fenpropathrin in Three Aquatic Systems, Under Anaerobic Conditions^A

Anaerobic Sediment 1

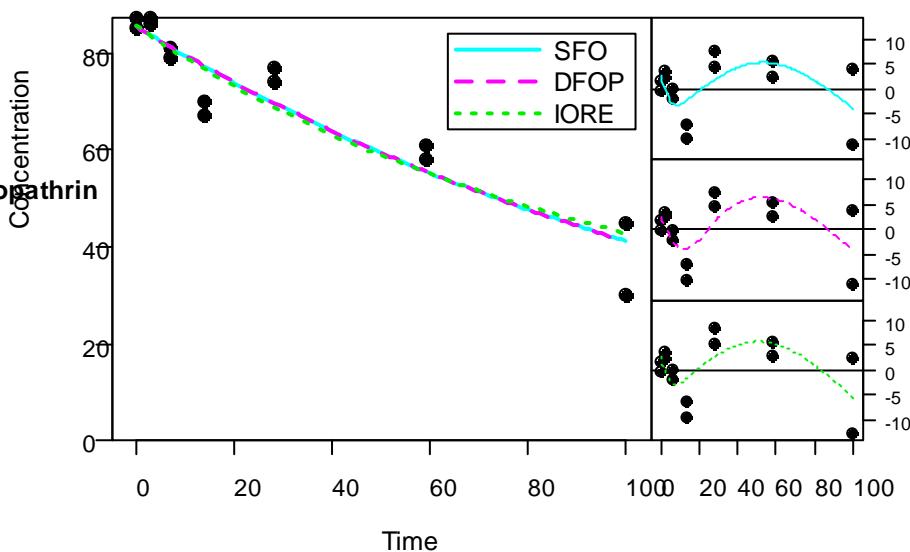


Anaerobic Sediment 2



Anaerobic Sediment 3

Da	% Fenpropidin
0	87.0
0	85.0
.	86.0
.	87.0
.	81.0
1	79.0
1	70.0
1	67.0
2	74.0
2	77.0
5	58.0
5	61.0
10	30.0
10	45.0

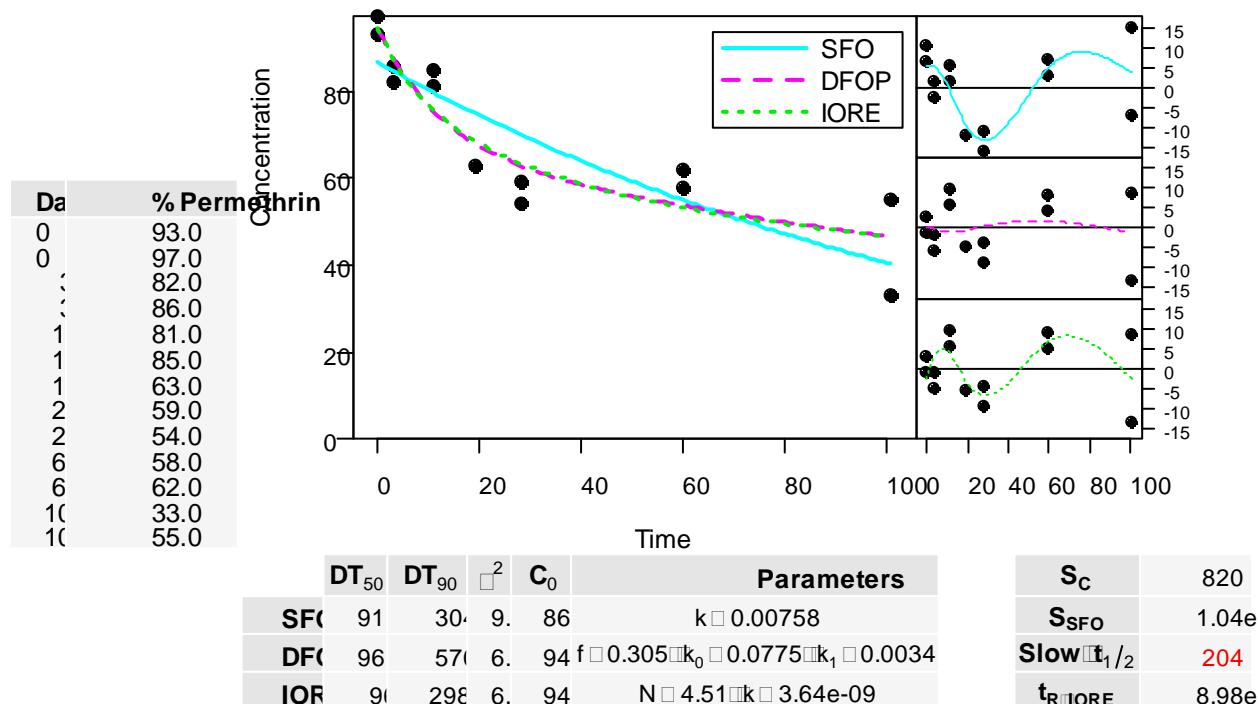


	DT_{50}	DT_{90}	\square^2	C_0	Parameters		S_C	565
SFO	94	31	5.	85	$k \square 0.0073$		S_{SFO}	427
DFP	94	31	6.	85	$f \square 0.449 \square k_0 \square 0.00731 \square k_1 \square 0.0073$		Slow $t_{1/2}$	94.9
IOR	10	51	5.	85	$N \square 1.49 \square k \square 0.000952$		t_{RIORE}	155

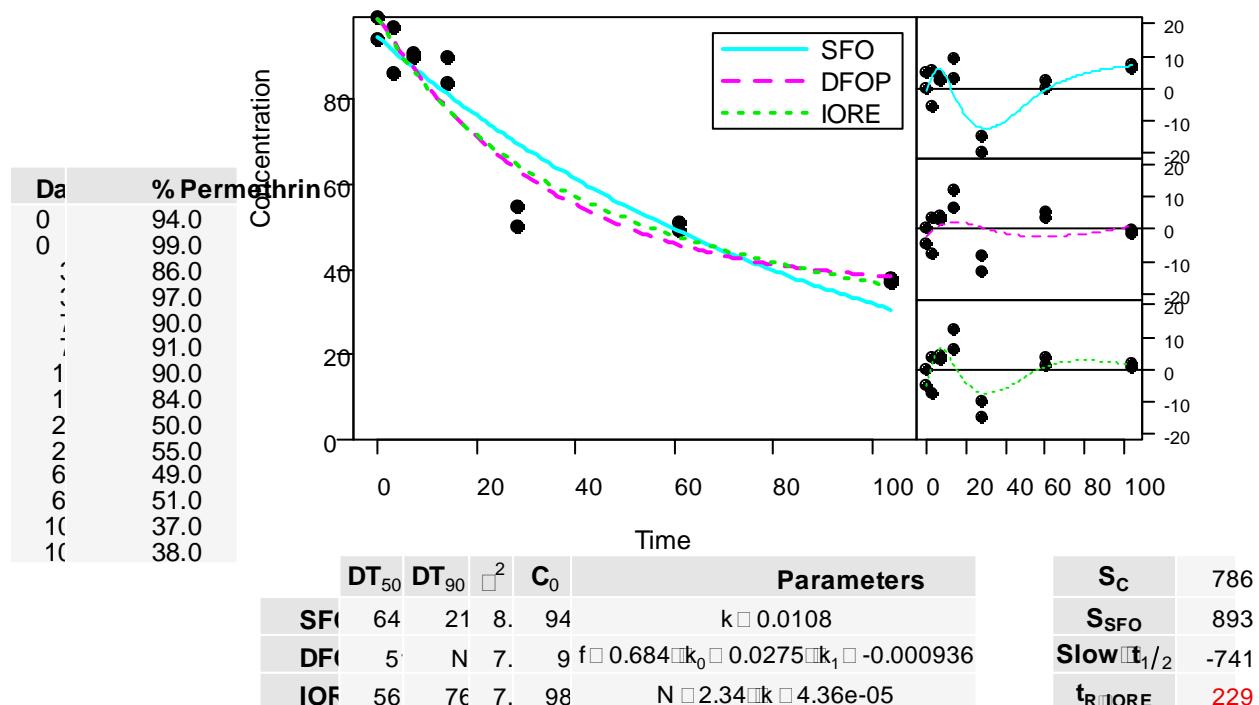
^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

Table 9x. Degradation Kinetics of Permethrin in Three Aquatic Systems, Under Anaerobic Conditions^A

Anaerobic Sediment 1

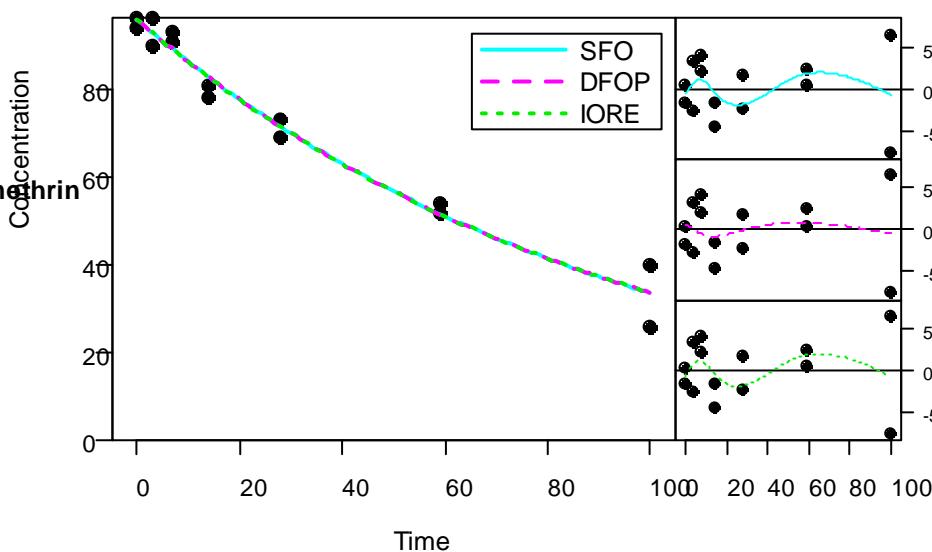


Anaerobic Sediment 2



Anaerobic Sediment 3

Da	% Permeathrin
0	96.0
0	94.0
.	90.0
.	96.0
.	91.0
1	93.0
1	81.0
2	78.0
2	73.0
5	69.0
5	54.0
10	52.0
10	26.0
10	40.0



	DT_{50}	DT_{90}	\square^2	C_0	Parameters	S_C	220
SFO	66	22	1.	95	$k \square 0.0105$	S_{SFO}	179
DFOP	66	22	2.	95	$f \square 0.249 \square k_0 \square 0.0121 \square k_1 \square 0.00998$	Slow $t_{1/2}$	69.5
IORE	66	22	2.	95	$N \square 1 \square k \square 0.0103$	t_{RIORE}	66.4

^A Data were obtained from Tables 14 and 15 (pp. 41-46) of study report. See Attachment 2 for raw data.

III. Study Deficiencies and Reviewer's Comments

- 1) The purpose of this study was to provide sediment half-lives for selected synthetic pyrethroids and it was conducted per the California Department of Pesticide Regulations (CDPR) request. The study was not conducted per OCSPP guidance, where the water and sediment are tested separately. Instead, water and sediment were extracted together.
- 2) Non-radiolabeled material was used in this study; therefore, the presence of possible transformation products was not verified. Further, the possibility of presence of unextracted residues could not be precluded.
- 3) The runs were conducted for a period of up to only 108 days while for many of the pyrethroids, the calculated DT₅₀s and/or DT₉₀s were above 100-108 days, rendering the calculated half-lives uncertain. For more persistent pyrethroids, testing should have been conducted for 365 days.
- 4) The results of this study were also published in the open literature (Meyer *et al.* 2013; refer to next section for the reference).
- 5) For some of the pyrethroids, the amount remaining towards the end of the studies decreased to levels below the LOQ (10% of the applied amount). In such cases, and consistent with the current SOP (USEPA 2012), these values were utilized in the calculation of the representative half-lives with PestDF.
- 6) For two of the aerobic sediments, conditions may not have been fully aerobic (for Sediment 2 (clay) and Sediment 3 (sandy clay loam)). The measured potentials were 65.4-100.9 mV during the test in Sediment 2 and 58.8-165.2 mV for Sediment 3. Redox conditions from approximately -100 mV to +400 mV represent suboxic environmental conditions (Sposito, 1989). Under these conditions, bacteria can use either oxygen or other elements (N, Mn, Fe) as the electron acceptor. Because anaerobic metabolism studies are often poised (buffered) at suboxic redox conditions, the Agency considers anaerobic studies when the redox potential (Eh) are less than 296 mV. This represents redox potential where aerobic microorganisms that utilize oxygen to oxidize organic matter do not function (Sposito, 1989). It is apparent that the sediments were slightly anaerobic. Since for synthetic pyrethroids partition with sediments, the sediment potential is critical in confirming the aerobicity of the systems. It is acknowledged that the water potentials and oxygen content appeared to indicate aerobicity in the water. It is also acknowledged that the anaerobic systems presented lower oxygen content and redox potentials than the aerobic systems.
- 7) C₀ values (representative of the initial concentration calculated by PestDF) were very low (<<100% which is the theoretical value), indicating that in many cases the recoveries of pesticide chemical were low. Concurrent recoveries from Test Mixtures 1 and 2 in Sediments 1, 2, and 3, appeared to indicate otherwise regarding recoveries (Tables 10 and 11, pp. 33-34).

IV. References

- FOCUS. 2006. Guidance Document on Estimating Persistence and Degradation Kinetics from Environmental Fate Studies on Pesticides in EU Registration. Report of the FOCUS Work Group on Degradation Kinetics, EC Document Reference Sanco/10058/2005 version 2.0, 434 pp.
- Meyer, B.N., C. Lam, S. Moore, and R.L. Jones. 2013. Laboratory Degradation Rates of 11 Pyrethroids under Aerobic and Anaerobic Conditions. *J. Agric. Food Chem.* 2013, 61, 4702–4708¹
- United States Environmental Protection Agency (USEPA), Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA): Good Laboratory Practice Standards; Final Rule; Federal Register 40 CFR Part 160 (1989)
- Sposito, G. 1989. *The Chemistry of Soils*. Oxford Univ. Press, New York.
- USEPA 2008. Fate, Transport and Transformation Test Guidelines, OPPTS 835.4300/ 835.4400, USEPA, 712-C-08-018/019, October 2008
- USEPA 2011. NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media, NAFTA Technical Working Group on Pesticides, available at <http://www.epa.gov/oppfead1/international/naftatwg/guidance/degradation-kin.pdf>.
- USEPA 2012. Standard Operating Procedure for Using the NAFTA Guidance to Calculate Representative Half-life Values and Characterizing Pesticide Degradation, dated November 30, 2012 and approved December 17, 2012.

¹ dx.doi.org/10.1021/jf400382u

Attachment 1: Chemical Names and Structures

TABLE 1.1. Test Compound Nomenclature²

Common name	Bifenthrin
Company experimental name	Not reported.
IUPAC name	2-Methylbiphenyl-3-ylmethyl (Z)-(1RS,3RS)-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate.
CAS Name	(2-Methyl[1,1'-biphenyl]-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	82657-04-3.
Structure	<p>(Z)-(1R)-cis-acid</p> <p>(Z)-(1S)-cis-acid</p>
Common name	Cypermethrin.
Company experimental name	Not reported.
IUPAC name	(RS)- α -Cyano-3-phenoxybenzyl (1RS,3RS;1RS,3SR)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate.
CAS Name	Cyano(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	52315-07-8.
Structure	
Common name	Zeta-cypermethrin
Company experimental name	Not reported.

² Structures were obtained at http://www.alanwood.net/pesticides/index_cn_frame.html (accessed 07/17/2013).

TABLE 1.1. Test Compound Nomenclature²

IUPAC name	(<i>RS</i>)- α -cyano-3-phenoxybenzyl (1 <i>S</i> ,3 <i>S</i> ;1 <i>R</i> ,3 <i>S</i>)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate or (<i>RS</i>)- α -cyano-3-phenoxybenzyl (1 <i>R</i>)- <i>cis-trans</i> -3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate.
CAS Name	Cyano(3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	52315-07-8.
Structure	<p style="text-align: center;">(S)-alcohol (1<i>R</i>)-<i>cis</i>-acid</p> <p style="text-align: center;">(S)-alcohol (1<i>R</i>)-<i>trans</i>-acid</p> <p style="text-align: center;">(S)-alcohol (1<i>S</i>)-<i>cis</i>-acid</p> <p style="text-align: center;">(S)-alcohol (1<i>S</i>)-<i>trans</i>-acid</p>
Common name	Cyfluthrin.
Company experimental name	Not reported.
IUPAC name	(<i>RS</i>)- α -Cyano-4-fluoro-3-phenoxybenzyl (1 <i>S</i> ,3 <i>S</i> ;1 <i>R</i> ,3 <i>S</i>)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane carboxylate.

TABLE 1.1. Test Compound Nomenclature²

CAS Name	Cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	68359-37-5.
Structure	
Common name	Beta-cyfluthrin
Company experimental name	Not reported.
IUPAC name	Reaction mixture comprising the enantiomeric pair (<i>R</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>S</i> ,3 <i>S</i>)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (<i>S</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>R</i> ,3 <i>R</i>)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate in ratio 1:2 with the enantiomeric pair (<i>R</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>S</i> ,3 <i>R</i>)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (<i>S</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>R</i> ,3 <i>S</i>)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate or reaction mixture comprising the enantiomeric pair (<i>R</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>S</i>)- <i>cis</i> -3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (<i>S</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>R</i>)- <i>cis</i> -3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate in ratio 1:2 with the enantiomeric pair (<i>R</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>S</i>)- <i>trans</i> -3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate and (<i>S</i>)- α -cyano-4-fluoro-3-phenoxybenzyl (1 <i>R</i>)- <i>trans</i> -3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate.
CAS Name	Cyano(4-fluoro-3-phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	68359-37-5.

TABLE 1.1. Test Compound Nomenclature²

Structure	
Common name	Deltamethrin.
Company experimental name	Not reported.
IUPAC name	(S)- α -Cyano-3-phenoxybenzyl (1R,3R)-3-(2,2-dibromoethyl)-2,2-dimethylcyclopropanecarboxylate.
CAS Name	1-[R-[1- α -(S*),3 α]]-Cyano(3-phenoxyphenyl)methyl 3-(2,2-dibromoethyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	52918-63-5.

TABLE 1.1. Test Compound Nomenclature²

Structure	<p style="text-align: center;">(S)-alcohol (1R)-cis-acid</p>
Common name	Esfenvalerate.
Company experimental name	Not reported.
IUPAC name	(S)- α -Cyano-3-phenoxybenzyl (S)-2-(4-chlorophenyl)-3-methylbutyrate.
CAS Name	[S-(R*,R*)]-Cyano(3-phenoxyphenyl)methyl 4-chloro-2-(1-methylethyl)benzenecarboxylate.
CAS #	66230-04-4.
Structure	
Common name	Fenpropothrin.
Company experimental name	Not reported.
IUPAC name	(RS)- α -Cyano-3-phenoxybenzyl 2,2,3,3-tetramethylcyclopropanecarboxylate.
CAS Name	Cyano(3-phenoxyphenyl)methyl 2,2,3,3-tetramethylcyclopropanecarboxylate.
CAS #	64257-84-7.
Structure	
Common name	Lambda-cyhalothrin.
Company experimental name	Not reported.
IUPAC name	Reaction product of equal quantities of (S)- and (R)- α -cyano-3-phenoxybenzyl (Z)-(1R,3R)-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate.
CAS Name	[1 α (S*),3 α (Z)]-(\pm)-Cyano(3-phenoxyphenyl)methyl 3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	91465-08-6.

TABLE 1.1. Test Compound Nomenclature²

Structure	<p>(S)-alcohol (Z)-(1R)-cis-acid</p>
Common name	Gamma-cyhalothrin
Company experimental name	Not reported.
IUPAC name	(S)- α -cyano-3-phenoxybenzyl (1 <i>R</i> ,3 <i>R</i>)-3-[(<i>Z</i>)-2-chloro-3,3,3-trifluoropropenyl]-2,2-dimethylcyclopropanecarboxylate or (S)- α -cyano-3-phenoxybenzyl (1 <i>R</i>)- <i>cis</i> -3-[(<i>Z</i>)-2-chloro-3,3,3-trifluoropropenyl]-2,2-dimethylcyclopropanecarboxylate.
CAS Name	(S)-cyano(3-phenoxyphenyl)methyl (1 <i>R</i> ,3 <i>R</i>)-3-[(1 <i>Z</i>)-2-chloro-3,3,3-trifluoro-1-propen-1-yl]-2,2-dimethylcyclopropanecarboxylate.
CAS #	76703-62-3.
Structure	<p>(S)-alcohol (Z)-(1R)-cis-acid</p>
Common name	Permethrin.
Company experimental name	Not reported.
IUPAC name	3-Phenoxybenzyl (1 <i>RS</i> ,3 <i>RS</i> ;1 <i>RS</i> ,3 <i>SR</i>)-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylate.
CAS Name	(3-Phenoxyphenyl)methyl 3-(2,2-dichloroethenyl)-2,2-dimethylcyclopropanecarboxylate.
CAS #	52645-53-1.
Structure	

Attachment 2: Calculations

Calculations were performed by the reviewer using the program R routine named PestDFV1.0, and equations described in details in NAFTA Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media (2012) available at <http://www.epa.gov/oppfead1/international/naftatwg/guidance/degradation-kin.pdf>.

Single First-Order (SFO) Model

(eq. 1)

where,

C_t = concentration at time t (%)

C_0 = initial concentration (%)

e = Euler's number (-)

k = SFO rate constant of decline (d^{-1})

t = time (d)

The SFO equation is solved [with the Excel Solver] by adjusting C_0 and k to minimize the objective function (S_{SFO}) shown in equation 9.

$$DT_{50} = \ln(2)/k \quad (\text{eq. 2})$$

$$DT_{90} = \ln(10)/k \quad (\text{eq. 3})$$

Indeterminate Order Rate Equation (IORE) Model

—
(eq. 4)

where,

N = order of decline rate (-)

k_{IORE} = IORE rate constant of decline (d^{-1})

This equation is solved [with the Excel Solver] by adjusting C_0 , k_{IORE} , and N to minimize the objective function for IORE (S_{IORE}) (See equation 9). Half-lives for the IORE model are calculated using equation 5, which represents a first-order half-life that passes through the DT_{90} of the IORE model. (Traditional DT_{50} and DT_{90} values for the IORE model can be calculated using equations 6 and 7.)

—
(eq. 5)

$$DT_{50} = \frac{(C_0/2)^{(1-N)} - C_0^{(1-N)}}{k(N-1)} \quad (\text{eq. 6})$$

$$DT_{90} = \frac{(C_0/10)^{(1-N)} - C_0^{(1-N)}}{k(N-1)} \quad (\text{eq. 7})$$

Double First-Order in Parallel (DFOP) Model

(eq. 8)

where,

g = the fraction of C_0 applied to compartment 1 (-)

k_1 = rate constant for compartment 1 (d^{-1})

k_2 = rate constant for compartment 2 (d^{-1})

If $C_0 \times g$ is set equal to a and $C_0(1-g)$ is set equal to c , then the equation can be solved [with the Excel Solver] for a , c , k_1 , and k_2 by minimizing the objective function (S_{DFOP}) as described in equation 9.

DT_{50} and DT_{90} values can be calculated using equations 2 and 3, with k_1 or k_2 in place of k .

Objective Function: SFO, IORE, and DFOP are solved by minimizing the objective function (S_{SFO} , S_{IORE} , or S_{DFOP}).

(eq. 9)

where,

S_{SFO} , S_{IORE} , or S_{DFOP} = objective function of kinetics model fit ($\%^2$)

n = number of data points (-)

$C_{\text{model},t}$ = modelled value at time corresponding to $C_{d,t}$ (%)

$C_{d,t}$ = experimental concentration at time t (%)

Critical Value to Determine Whether SFO is an Adequate Kinetics Model

If S_{SFO} is less than S_c , the SFO model is adequate to describe kinetics. If not, the faster of t_{IORE} or the DFOP DT_{50} for compartment 2 should be used.

— (eq. 10)

where,

S_c = the critical value that defines the confidence contours ($\%^2$)

p = number of parameters (3 in this case)

α = the confidence level (0.50 in this case)

$F(\alpha, p, n-p)$ = F distribution with α level of confidence and degrees of freedom p and $n-p$

Attachment 3: Statistics Spreadsheets

Chemical: Bifenthrin
MRID: 48762908
Guideline: 835.4300 and 835.4400

Aerobic Sediment 1, Test Mixture 1

Day	% Bifenthrin
0	99
0	94
3	76
3	83
7	85
7	75
14	67
14	66
28	64
28	72
59	69
59	55
100	46
100	41

Anaerobic Sediment 1, Test Mixture 1

Day	% Bifenthrin
0	92
0	100
3	99
3	89
11	92
11	96
19	86
19	90
28	95
28	99
60	80
60	101
101	96
101	80

Aerobic Sediment 2, Test Mixture 1

Day	% Bifenthrin
0	81
0	72
3	94
3	100
7	88
7	90
14	94
14	99
28	94
28	86
60	93
60	100
103	70
103	68

Anaerobic Sediment 2, Test Mixture 1

Day	% Bifenthrin
0	70
0	75
3	76
3	79
7	74
7	74
14	81
14	79
28	94
28	86
61	74
61	73
104	60
104	55

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Bifenthrin
MRID: 48762908
Guideline: 835.4300 and 835.4400

Aerobic Sediment 3, Test Mixture 1

Day	% Bifenthrin
0	90
0	98
3	78
3	78
7	79
7	81
14	80
14	88
28	72
28	81
58	69
58	74
100	16
100	65

Anaerobic Sediment 3, Test Mixture 1

Day	% Bifenthrin
0	81
0	80
3	71
3	72
7	81
7	81
14	70
14	67
28	86
28	94
59	71
59	63
100	58
100	64

Aerobic Sediment 1, Test Mixture 2

Day	% Bifenthrin
0	112
0	108
3	93
3	97
7	88
7	92
14	77
14	75
28	79
28	84
59	73
59	74
100	36
100	55

Anaerobic Sediment 1, Test Mixture 2

Day	% Bifenthrin
0	91
0	87
3	97
3	99
11	92
11	96
19	84
19	88
28	86
28	87
60	99
60	112
101	80
101	92

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Bifenthrin
MRID: 48762908
Guideline: 835.4300 and 835.4400

Aerobic Sediment 2, Test Mixture 2

Day	% Bifenthrin
0	76
0	76
3	111
3	112
7	95
7	89
14	86
14	83
28	83
28	86
60	77
60	81
103	74
103	69

Anaerobic Sediment 2, Test Mixture 2

Day	% Bifenthrin
0	78
0	80
3	69
3	75
7	76
7	78
14	81
14	73
28	83
28	86
61	75
61	78
104	51
104	55

Aerobic Sediment 3, Test Mixture 2

Day	% Bifenthrin
0	95
0	94
3	84
3	87
7	87
7	90
14	79
14	81
28	86
28	83
58	77
58	47
100	45
100	27

Anaerobic Sediment 3, Test Mixture 2

Day	% Bifenthrin
0	78
0	76
3	75
3	77
7	81
7	79
14	76
14	75
28	83
28	83
59	63
59	64
100	60
100	63

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Beta-cyfluthrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Beta-cyfluthrin
0	97
0	95
3	44
3	47
7	31
7	28
14	15
14	11
28	11
28	9
59	9
59	7
100	5
100	4

Anaerobic Sediment 1

Day	% Beta-cyfluthrin
0	94
0	97
3	57
3	57
11	51
11	51
19	48
19	39
28	32
28	48
60	22
60	23
101	21
101	15

Aerobic Sediment 2

Day	% Beta-cyfluthrin
0	94
0	98
3	63
3	71
7	54
7	50
14	32
14	37
28	27
28	26
60	14
60	15
103	9
103	9

Anaerobic Sediment 2

Day	% Beta-cyfluthrin
0	90
0	92
3	85
3	85
7	71
7	69
14	68
14	64
28	27
28	26
61	16
61	22
104	11
104	10

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Beta-cyfluthrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Beta-cyfluthrin
0	93
0	95
3	47
3	40
7	25
7	25
14	14
14	23
28	11
28	10
58	6
58	4
100	3
100	7

Anaerobic Sediment 3

Day	% Beta-cyfluthrin
0	96
0	94
3	78
3	80
7	72
7	74
14	46
14	50
28	39
28	40
59	17
59	15
100	8
100	8

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Cyfluthrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Cyfluthrin
0	97
0	91
3	56
3	57
7	34
7	33
14	15
14	15
28	13
28	14
59	9
59	6
100	5
100	8

Anaerobic Sediment 1

Day	% Cyfluthrin
0	97
0	92
3	76
3	82
11	84
11	87
19	48
19	43
28	36
28	33
60	25
60	24
101	18
101	24

Aerobic Sediment 2

Day	% Cyfluthrin
0	96
0	97
3	71
3	74
7	57
7	55
14	44
14	44
28	29
28	34
60	21
60	19
103	12
103	11

Anaerobic Sediment 2

Day	% Cyfluthrin
0	96
0	98
3	88
3	87
7	78
7	81
14	68
14	64
28	29
28	34
61	29
61	26
104	15
104	15

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Cyfluthrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Cyfluthrin
0	93
0	95
3	49
3	43
7	30
7	26
14	19
14	13
28	11
28	7
58	5
58	2
100	4
100	1

Anaerobic Sediment 3

Day	% Cyfluthrin
0	96
0	95
3	82
3	89
7	71
7	70
14	53
14	51
28	35
28	35
59	20
59	17
100	7
100	10

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Gamma-cyhalothrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Gamma-cyhalothrin
0	97
0	92
3	79
3	85
7	72
7	63
14	34
14	26
28	35
28	28
59	27
59	22
100	12
100	9

Anaerobic Sediment 1

Day	% Gamma-cyhalothrin
0	98
0	103
3	97
3	93
11	81
11	85
19	84
19	79
28	71
28	79
60	58
60	64
101	58
101	43

Aerobic Sediment 2

Day	% Gamma-cyhalothrin
0	89
0	88
3	85
3	94
7	87
7	83
14	69
14	78
28	60
28	57
60	40
60	47
103	27
103	28

Anaerobic Sediment 2

Day	% Gamma-cyhalothrin
0	76
0	85
3	82
3	97
7	90
7	88
14	103
14	97
28	60
28	57
61	52
61	64
104	50
104	44

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Gamma-cyhalothrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Gamma-cyhalothrin
0	96
0	105
3	76
3	75
7	55
7	60
14	45
14	62
28	40
28	36
58	21
58	21
100	2
100	16

Anaerobic Sediment 3

Day	% Gamma-cyhalothrin
0	103
0	91
3	93
3	96
7	89
7	90
14	85
14	85
28	81
28	82
59	60
59	56
100	31
100	35

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Lambda-cyhalothrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Lambda-cyhalothrin
0	102
0	97
3	90
3	100
7	68
7	74
14	34
14	46
28	45
28	43
59	32
59	28
100	14
100	24

Anaerobic Sediment 1

Day	% Lambda-cyhalothrin
0	96
0	99
3	92
3	95
11	60
11	63
19	75
19	80
28	70
28	66
60	52
60	57
101	40
101	54

Aerobic Sediment 2

Day	% Lambda-cyhalothrin
0	88
0	89
3	94
3	95
7	85
7	79
14	61
14	71
28	57
28	65
60	50
60	48
103	32
103	24

Anaerobic Sediment 2

Day	% Lambda-cyhalothrin
0	93
0	92
3	88
3	88
7	92
7	93
14	89
14	93
28	57
28	65
61	62
61	61
104	43
104	46

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Lambda-cyhalothrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Lambda-cyhalothrin
0	98
0	100
3	74
3	77
7	65
7	66
14	48
14	45
28	36
28	28
58	26
58	7
100	5
100	2

Anaerobic Sediment 3

Day	% Lambda-cyhalothrin
0	100
0	87
3	84
3	96
7	87
7	81
14	84
14	70
28	68
28	69
59	47
59	54
100	24
100	33

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Zeta-cypermethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Zeta-cypermethrin
0	93
0	88
3	51
3	56
7	36
7	30
14	15
14	13
28	13
28	11
59	11
59	10
100	7
100	5

Anaerobic Sediment 1

Day	% Zeta-cypermethrin
0	93
0	94
3	74
3	72
11	60
11	63
19	49
28	44
28	59
60	31
60	35
101	30
101	23

There is only one valid sample at 19 days posttreatment

Aerobic Sediment 2

Day	% Zeta-cypermethrin
0	96
0	100
3	74
3	80
7	64
7	62
14	44
14	49
28	35
28	35
60	21
60	24
103	13
103	14

Anaerobic Sediment 2

Day	% Zeta-cypermethrin
0	90
0	95
3	87
3	91
7	83
7	81
14	78
14	69
28	35
28	35
61	25
61	32
104	21
104	19

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Zeta-cypermethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Zeta-cypermethrin
0	92
0	93
3	56
3	52
7	32
7	34
14	17
14	30
28	14
28	15
58	9
58	6
100	2
100	6

Anaerobic Sediment 3

Day	% Zeta-cypermethrin
0	96
0	94
3	86
3	87
7	79
7	82
14	65
14	64
28	53
28	55
59	30
59	28
100	14
100	16

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Cypermethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Cypermethrin
0	96
0	94
3	52
3	55
7	27
7	25
14	13
14	12
28	10
28	11
59	7
59	4
100	4
100	6

Anaerobic Sediment 1

Day	% Cypermethrin
0	95
0	96
3	76
3	80
7	87
7	87
14	43
28	35
28	31
60	24
60	25
101	17
101	23

There is only one valid sample at 19 days posttreatment

Aerobic Sediment 2

Day	% Cypermethrin
0	98
0	100
3	73
3	73
7	58
7	51
14	40
14	40
28	25
28	30
60	19
60	18
103	9
103	9

Anaerobic Sediment 2

Day	% Cypermethrin
0	95
0	96
3	86
3	87
7	79
7	80
14	67
14	62
28	25
28	30
61	29
61	26
104	13
104	12

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Cypermethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Cypermethrin
0	91
0	95
3	43
3	42
7	25
7	20
14	15
14	11
28	8
28	5
58	5
58	2
100	3
100	1

Anaerobic Sediment 3

Day	% Cypermethrin
0	99
0	97
3	88
3	90
7	73
7	70
14	54
14	54
28	36
28	37
59	19
59	17
100	7
100	9

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Deltamethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Deltamethrin
0	103
0	98
3	87
3	89
7	65
7	60
14	35
14	37
28	13
28	11
59	11
59	10
100	7
100	5

Anaerobic Sediment 1

Day	% Deltamethrin
0	102
0	100
3	90
3	91
11	87
11	87
19	73
28	71
28	80
60	55
60	63
108	53
108	46

There is only one valid sample at 19 days posttreatment

Aerobic Sediment 2

Day	% Deltamethrin
0	94
0	98
3	90
3	96
7	88
7	91
14	65
14	73
28	56
28	54
60	36
60	39
103	27
103	26

Anaerobic Sediment 2

Day	% Deltamethrin
0	98
0	99
3	102
3	98
7	98
7	93
14	91
14	93
28	56
28	54
61	46
61	56
104	46
104	43

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Deltamethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Deltamethrin
0	102
0	103
3	72
3	80
7	53
7	58
14	35
14	51
28	32
28	27
58	19
58	14
100	8
100	14

Anaerobic Sediment 3

Day	% Deltamethrin
0	103
0	100
3	96
3	95
7	91
7	92
14	79
14	81
28	77
28	74
59	52
59	51
100	28
100	31

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Esfenvalerate

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Esfenvalerate
0	93
0	89
3	79
3	85
7	69
7	60
14	40
14	36
28	29
28	24
59	31
59	25
100	16
100	11

Anaerobic Sediment 1

Day	% Esfenvalerate
0	96
0	96
3	97
3	90
7	84
7	87
14	73
28	70
28	76
60	52
60	57
101	55
101	47

There is only one valid sample at 19 days posttreatment

Aerobic Sediment 2

Day	% Esfenvalerate
0	98
0	103
3	87
3	93
7	84
7	88
14	64
14	64
28	61
28	58
60	40
60	42
103	28
103	30

Anaerobic Sediment 2

Day	% Esfenvalerate
0	91
0	94
3	91
3	95
7	92
7	87
14	97
14	92
28	61
28	58
61	45
61	56
104	42
104	39

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Esfenvalerate

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Esfenvalerate
0	96
0	102
3	80
3	81
7	66
7	69
14	59
14	69
28	43
28	37
58	26
58	19
100	3
100	20

Anaerobic Sediment 3

Day	% Esfenvalerate
0	103
0	99
3	88
3	91
7	92
7	93
14	86
14	81
28	68
28	74
59	55
59	55
100	33
100	34

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Fenpropathrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Fenpropathrin
0	99
0	97
3	73
3	78
7	48
7	51
14	30
14	26
28	24
28	23
59	16
59	14
100	8
100	12

Anaerobic Sediment 1

Day	% Fenpropathrin
0	97
0	99
3	91
3	91
11	51
11	51
19	72
28	66
28	65
60	50
60	50
101	48
101	53

There is only one valid sample at 19 days posttreatment

Aerobic Sediment 2

Day	% Fenpropathrin
0	86
0	87
3	97
3	98
7	84
7	77
14	69
14	69
28	59
28	64
60	53
60	57
103	26
103	25

Anaerobic Sediment 2

Day	% Fenpropathrin
0	83
0	85
3	78
3	84
7	81
7	82
14	88
14	82
28	59
28	64
61	62
61	64
104	41
104	47

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Fenpropathrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Fenpropathrin
0	93
0	92
3	70
3	62
7	54
7	39
14	29
14	22
28	29
28	14
58	13
58	5
100	2
100	1

Anaerobic Sediment 3

Day	% Fenpropathrin
0	87
0	85
3	86
3	87
7	81
7	79
14	70
14	67
28	74
28	77
59	58
59	61
100	30
100	45

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Permethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 1

Day	% Permethrin
0	96
0	94
3	42
3	45
7	19
7	20
14	13
14	10
28	9
28	10
59	3
59	3
100	5
100	6

Anaerobic Sediment 1

Day	% Permethrin
0	93
0	97
3	82
3	86
11	81
11	85
19	63
28	59
28	54
60	58
60	62
101	33
101	55

There is only one valid sample at 19 days posttreatment

Aerobic Sediment 2

Day	% Permethrin
0	93
0	96
3	84
3	79
7	70
7	62
14	62
14	60
28	50
28	55
60	44
60	42
103	24
103	25

Anaerobic Sediment 2

Day	% Permethrin
0	94
0	99
3	86
3	97
7	90
7	91
14	90
14	84
28	50
28	55
61	49
61	51
104	37
104	38

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Permethrin

MRID: 48762908

Guideline: 835.4300 and 835.4400

Aerobic Sediment 3

Day	% Permethrin
0	104
0	96
3	48
3	40
7	24
7	16
14	14
14	12
28	15
28	11
58	5
58	2
100	2
100	2

Anaerobic Sediment 3

Day	% Permethrin
0	96
0	94
3	90
3	96
7	91
7	93
14	81
14	78
28	73
28	69
59	54
59	52
100	26
100	40

Data were obtained from Tables 12-15 (pp. 35-46) of study report.

Chemical: Pyrethroids

MRID: 48762908

Guideline: 835.4400

Water: Sediment 1

Aqueous phase

Day	Measured Eh	Measured pH	pE	pE+pH	pE+pH < 12?
0	178.0	7.0	3.0	10.0	Yes
3	138.2	7.1	2.3	9.4	Yes
7	140.6	7.0	2.4	9.4	Yes
11	131.0	6.9	2.2	9.1	Yes
19	114.4	7.1	1.9	9.0	Yes
28	88.5	7.0	1.5	8.5	Yes
60	88.1	7.0	1.5	8.5	Yes
101	10.3	6.9	0.2	7.1	Yes
108	1.6	7.0	0.0	7.0	Yes

Data from p. 28 (Table 5) of the study report.

Water: Sediment 1

Sediment phase

Day	Measured Eh	Measured pH	pE	pE+pH	pE+pH < 12?
0	170.2	7.0	2.9	9.9	Yes
3	126.4	7.1	2.1	9.2	Yes
7	132.2	7.0	2.2	9.2	Yes
11	125.9	6.9	2.1	9.0	Yes
19	108.2	7.1	1.8	8.9	Yes
28	81.4	7.0	1.4	8.4	Yes
60	73.3	7.0	1.2	8.2	Yes
101	0.0	6.9	0.0	6.9	Yes
108	9.6	7.0	0.2	7.2	Yes

Data from p. 28 (Table 5) of the study report.

Chemical: Pyrethroids
 MRID: 48762908
 Guideline: 835.4400

Water: Sediment 2

Aqueous phase

Day	Measured Eh	Measured pH	pE	pE+pH	pE+pH < 12?
0	104.2	6.6	1.8	8.4	Yes
3	95.4	6.7	1.6	8.3	Yes
7	109.8	6.3	1.9	8.2	Yes
14	104.7	6.3	1.8	8.1	Yes
28	103.4	6.7	1.7	8.4	Yes
61	107.7	6.6	1.8	8.4	Yes
104	100.9	6.7	1.7	8.4	Yes

Data from p. 28 (Table 5) of the study report.

Water: Sediment 2

Sediment phase

Day	Measured Eh	Measured pH	pE	pE+pH	pE+pH < 12?
0	100.5	6.6	1.7	8.3	Yes
3	106.5	6.7	1.8	8.5	Yes
7	112.6	6.3	1.9	8.2	Yes
14	101.5	6.3	1.7	8.0	Yes
28	102.7	6.7	1.7	8.4	Yes
61	105.4	6.6	1.8	8.4	Yes
104	98.6	6.7	1.7	8.4	Yes

Data from p. 28 (Table 5) of the study report.

Chemical: Pyrethroids

MRID: 48762908

Guideline: 835.4400

Water: Sediment 3

Aqueous phase

Day	Measured Eh	Measured pH	pE	pE+pH	pE+pH < 12?
0	59.5	6.7	1.0	7.7	Yes
3	54.6	6.8	0.9	7.7	Yes
7	59.9	6.7	1.0	7.7	Yes
14	53.9	6.8	0.9	7.7	Yes
28	49.0	6.8	0.8	7.6	Yes
59	58.3	6.8	1.0	7.8	Yes
100	48.6	6.9	0.8	7.7	Yes

Data from p. 28 (Table 5) of the study report.

Water: Sediment 3

Sediment phase

Day	Measured Eh	Measured pH	pE	pE+pH	pE+pH < 12?
0	56.9	6.7	1.0	7.7	Yes
3	44.3	6.8	0.7	7.5	Yes
7	55.7	6.7	0.9	7.6	Yes
14	49.8	6.8	0.8	7.6	Yes
28	52.6	6.8	0.9	7.7	Yes
59	55.0	6.8	0.9	7.7	Yes
100	50.2	6.9	0.8	7.7	Yes

Data from p. 28 (Table 5) of the study report.

Chemical: Esfenvalerate Anaerobic Sediment 1

MRID: 48762908

Guideline: 835.4400

0.8.7

DAT	Parent	SFO	DFOP	IORE	SFO - data	IORE - data	DFOP-data
0	96	92.8	79.4	97.1	-3.2	1.1	-16.5959
0	96	92.8	79.4	97.1	-3.2	1.1	-16.5959
3	97	90.8	78.3	92.8	-6.2	-4.2	-18.6682
3	90	90.8	78.3	92.8	0.8	2.8	-11.6682
11	84	85.6	75.5	83.8	1.6	-0.2	-8.45717
11	87	85.6	75.5	83.8	-1.4	-3.2	-11.4572
19	73	80.8	72.9	77.1	7.8	4.1	-0.14688
28	70	75.6	69.9	71.3	5.6	1.3	-0.0585
28	76	75.6	69.9	71.3	-0.4	-4.7	-6.0585
60	52	59.8	60.5	58.3	7.8	6.3	8.499889
60	57	59.8	60.5	58.3	2.8	1.3	3.499889
101	55	44.3	50.2	49.1	-10.7	-5.9	-4.75869
101	47	44.3	50.2	49.1	-2.7	2.1	3.241314

Chemical: Esfenvalerate Anaerobic Sediment 1

MRID: 48762908

Guideline: 835.4400

1. Input data in column A and B with time 0 beginning in row 3. If you have more than one replicate,

2. Copy equations from first column to the rows below to make sure that all data points have

3. Update the following cells to account for number of data points, Siore, Ssfo, Sdfop, graphing cells

minimuze is L17 by changing L14, L15, and L16.

5. Use Solver to fit SFO. Minimize Ssfo by adjusting Kfirst and C0

cells (J23) covers the range of cells in the G column that have data in them

use proceed to next steps.

by changing k1, k2, a, and c.

IODE MODEL		
K		0.00
N iore		3.23
Co iore		97.10
Siore		158.95
DT50		104.41
DT90		4775.22
Tiore (DT50 from DT90)		1437.48

First Order Model		DFOP	from solver
kfirst=	0.00732	C0 g or a	78.77
Co First	92.80	Co (1-g) or c	0.64
Ssfo	346.47	k1 (b)	4.53E-03
dt50	94.6922	k2 (d)	4.53E-03
dt90	314.56		
DT50 from DT90	94.68	Sdfop	1392.66
		1-DT50	152.95
		2-DT50	152.91

Misc

Data		
points (N)	13	g
p	3	0.7285
N-p	10	0.951472

FINV (0.5,
p, N-p) 0.85
Sc 199.24

1-N -2.23

log2/log1

0 0.30103

Conclusion:

DT50 for SF ln(2)/k

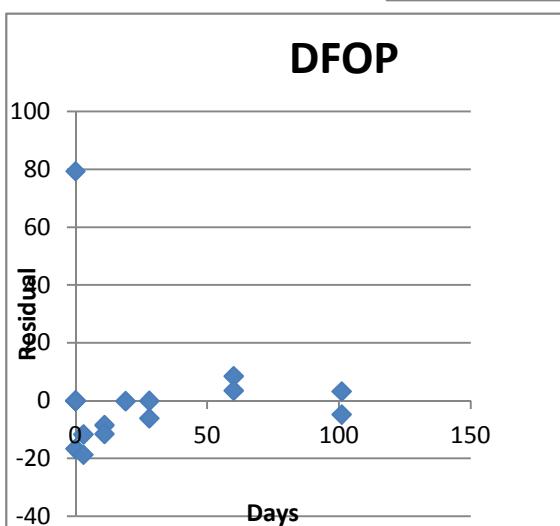
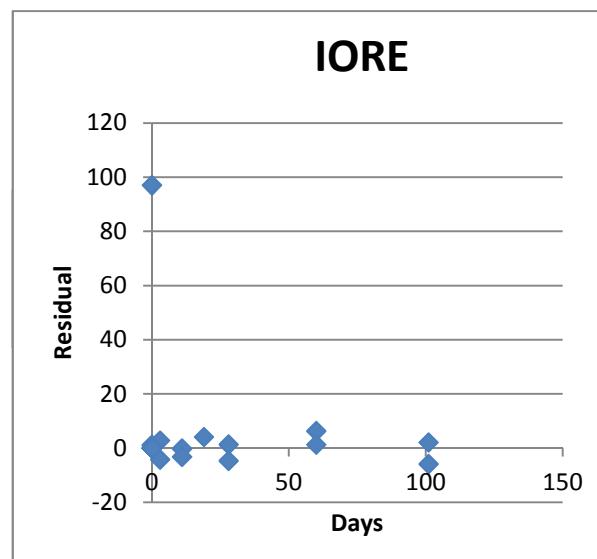
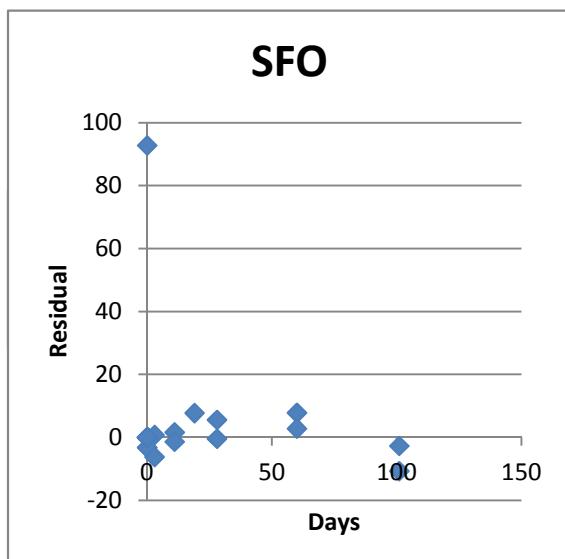
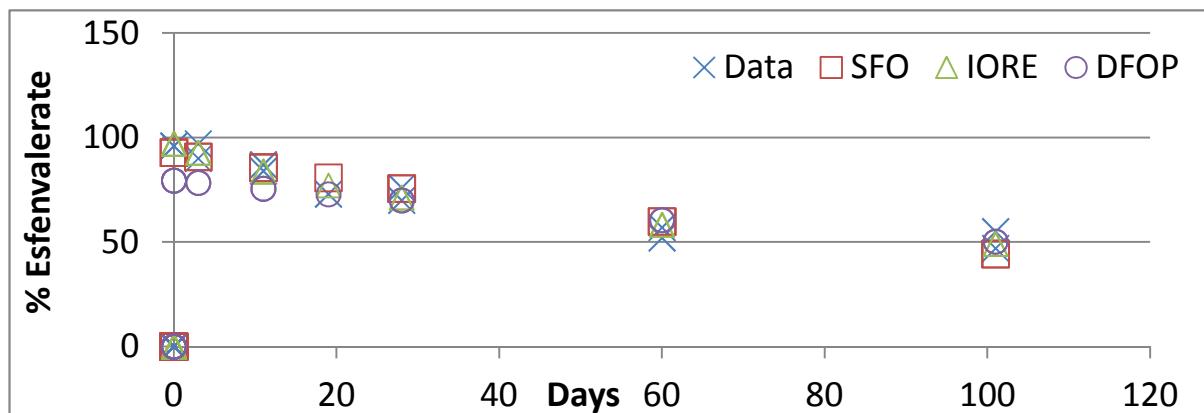
DT90 for SI ln(10)/k

DT50 for IC ((Co/2)^(1-N))-(Co^(1-N)))/(k*(N-1))

Chemical: Esfenvalerate Anaerobic Sediment 1

MRID: 48762908

Guideline: 835.4400



Chemical: Pyrethroids

MRID: 48762908

Guideline: 835.4400

Results from PestDF for Comparison Purposes

Anaerobic Sediment 1

